Do the Laws of Tax Incidence Hold? Point of Collection and the Pass-through of State Diesel Taxes

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Abstract

The canonical theory of taxation holds that the incidence of a tax is independent of the side of the market which is responsible for remitting the tax to the government. However, this prediction does not survive in certain circumstances, for example when the ability to evade taxes differs across economic agents. In this paper, we estimate in the context of state diesel fuel taxes how the incidence of a quantity tax depends on the point of tax collection, where the level of the supply chain responsible for remitting the tax varies across states and over time. Our results indicate that moving the point of tax collection from the retail station to higher in the supply chain substantially raises the pass-through of diesel taxes to the retail price. Furthermore, tax revenues respond positively to collecting taxes from the distributor or prime supplier rather than from the retailer, suggesting that evasion is the likely explanation for the incidence result.

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1 Introduction

The independence between statutory and economic incidence of a tax is a widely accepted result in the theory of taxation. The textbook law of tax incidence holds that the party responsible for remitting the tax to the government has no impact on who actually bears the burden, at least in the long run. Despite its general acceptance, this law holds only under special circumstances. In particular, when parties differ in their ability to evade taxes, the identity of the tax remitter may impact the pattern of post-tax prices and therefore the location of their burden. Due to different evasion technologies available to the different sides of a market, a tax levied on the demand side may shift the demand curve to a different degree than a similar tax levied on supply side would shift the supply curve.

This issue is relevant to the current debate on whether a carbon tax should be levied on upstream suppliers or downstream users. Opportunities to avoid taxes vary at different points in the supply chain. Although a number of papers (e.g. Metcalf (2009), Neimeier et al. (2008), Fischer et al. (1998)) highlight the administrative, distributional and political advantages of levying a carbon tax at different points in the supply chain, the literature largely assumes away an impact on the incidence of taxes. For example, Metcalf (2009) notes "One might argue that it would be better to levy the tax downstream because the carbon price would be more visible to end users and thus more likely to figure into energy consumption and planning decisions. Such an argument ignores a basic principle of tax incidence analysis: the ultimate burden and behavioral response to a tax does not depend on where in the production process the tax is levied." Similarly, Fischer et al. (1998) comments "...a downstream approach will have the same ultimate effects on fossil fuel and other prices as an upstream program. This corollary of the basic proposition that the ultimate incidence of a tax is independent of where it is applied is frequently misunderstood by proponents of downstream-based GHG emissions trading."

In this paper, we empirically examine how the identity of the tax remitter affects incidence in the diesel fuel market and present empirical evidence that the identity of the remitting party affects both collections and the incidence of taxes. Our context is state diesel fuel taxes. States differ in the stage of the supply chain responsible for remitting the tax (none require final consumer remittance), and over time states have in general moved the point of tax collection to higher in the supply chain. In the early 1980s, states were almost evenly split between collecting taxes from retail stations and collecting from intermediate wholesale distributors. Over the subsequent twenty years, many states have moved away from collecting from retail stations and toward collecting from prime suppliers. States changed tax collection regimes at

different point in time, a fact which we will exploit in this paper.

In addition to the considerable variation in the point of collection, the nature of tax evasion in the diesel market makes it a desirable setting for studying the effect of remittance on incidence. Several factors contribute to creating opportunities for evading diesel taxes. Due to fixed per-firm costs, it is relatively costly to monitor the remittance of the tax when there are many remitters each responsible for a small fraction of total revenue, as when taxes are collected from retail stations. Also, variation in tax rates across jurisdictions and across the uses of diesel create opportunities for misstating the ultimate state of sale or the intended use of a gallon of diesel.[1] Importantly, the opportunities for evasion differ considerably across the stages of the supply chain. For instance, hiding taxed sales is more difficult for prime suppliers because they are relatively less costly to monitor. On the other hand, a gallon of diesel sold at the retail level is usually intended for on-highway use, so retailers will find it more difficult to evade by misstating the intended use or state of sale. Which form of evasion is more important for tax collection is an empirical matter.

We find that the rate of pass-through of diesel taxes to retail prices is dependent on the location of remittance responsibility. Retail diesel prices are higher, and diesel taxes are passed through to retail prices to a greater extent, in states where the point of collection is at the distributor or prime supplier level rather than the retail level. This suggests that this collection regime reduces evasion. Lending credence to this result, we are able to trace the impact of collecting at the prime supplier level through the supply chain. An increase in the tax raises the wholesale price in supplier-remitting states, though not in retailer-remitting states. Moreover, conditional on the wholesale price, supplier remittance has no effect on pass-through. In other words, the effect of an increase in taxes on retail prices in supplier remitting states can be entirely explained via their effect on wholesale prices.

To examine tax evasion as an explanation for this result, we estimate the response of tax collections to the point of tax collection. We find evidence suggesting that, ceteris paribus states see less tax revenue when taxes are collected at the retail level. This is consistent with the incidence results, which suggest that retailers have more ability to evade taxes than higher levels of the supply chain.

The tax collection regime is unlikely to be randomly assigned, and may be chosen in a way that maximizes revenues or minimizes the cost of tax collection. While this may suggest that our estimated effects of the tax collection regime are local, heterogenous treatment effects are less

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[1]As we discuss below, the rate of tax on diesel fuel depends on whether the fuel is used for residential heating or for commercial purposes.

of a concern in this paper since we are merely testing a null hypothesis of tax collection regime having *no* effect on the pass-through of prices. More importantly, however, is the concern that unobserved variables may influence both evasion and the tax regime. To alleviate such concerns, we exploit the timing of changes in tax collection regime, showing that both incidence and collections change discontinuously at the date of the change in remitting party.

The tax literature has recognized for some time the importance of tax administration and collection, such as Musgrave (1969). Sorensen (1994), Kau and Rubin (1981), and Balke and Gardner (1991) suggest links between the size of government or the structure of tax systems and tax administration. However, theoretical work has largely ignored the implications of evasion and tax collection on incidence, with a possible exception being Tanzi (1992). Slemrod (2008) suggests that statutory and economic incidence are not necessarily independent in the presence of evasion, and discusses the conditions under which the textbook invariance principle fails.

Despite its prominent place in the theory of taxation, there is scant empirical work testing the independence of statutory incidence. Saez et al (2012) examine the payroll tax in Greece, where a rule change extended the earnings cap for individuals starting work in 1993 or later. They find that the increase in the employer portion of the tax was passed through to wages, while the employee portion was not, perhaps since posted salaries exclude the employer portion of the payroll tax. The authors suggest that institutional factors may therefore play an important role in the incidence of a tax.

The nature of tax enforcement and how it affects parties at different points in the supply chain is considered in the context of the value-added tax (VAT) by De Paula and Scheinkman (2010). They show that the self-enforcing nature of the VAT leads to spillovers in informality between firms at neighboring levels of the supply chain. In related work, Pomeranz (2011) finds in a randomized field experiment that random audit announcements are transmitted to the compliance behavior of firms up the supply chain.

A handful of recent studies have estimated the pass-through rate of fuel taxes to retail prices. Doyle and Samphantharak (2008) estimate the effect of gas tax holidays in Illinois and Indiana on retail prices. Marion and Muehlegger (2011) estimate the dependence of the pass-through rate of fuel taxes on a variety of factors related to supply conditions in the fuel market. Other relevant work in the pass-through rate of fuel taxation include Alm et al (2009), Chouinard and Perloff (2004,2007).[2] The literature related to the pass-through rate of retail sales taxes more

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[2]Early empirical work on incidence includes Due (1954), Brownlee and Perry (1967), Woodard and Siegelman (1967), and Sidhu (1971). Chernick and Reschovsky (1997) consider the distributional impact of the gasoline tax by examining gasoline expenditures across different deciles of the income and expenditure distribution.

broadly is more sparse, as suggested by Poterba (1996). Besley and Rosen (1999), who estimate the pass-through rate of city sales taxes to prices for twelve commodoties, is an exception. A number of papers including Sung, Hu and Keeler (1994), Barnett et al (1995), Delipalla and O'Donnell (2001), Harding et al (2009), and Chiou and Muehlegger (2009) estimate cigarette tax incidence. A smaller literature has examined the incidence of labor market taxes, which are often assumed to be fully borne by workers (Fullerton and Metcalf, 2002). Rothstein (2009) finds that the EITC expansion in the 1990s reduced wages among low-skilled workers, so that low-skilled single mothers benefitted by only 70 cents per dollar of tax credits received. Wages declined for non-eligible low-skilled workers as well, which resulted in employers benefitting by 0.72 cents for every dollar of benefits.

Devereux et al (2007) consider competition between different jurisdictions in setting cigarette and gasoline taxes.[3] They suggest that interstate arbitrage is not important in this market, and find that a weighted average of neighboring states' tax rates has little effect on own-state gasoline taxes. However, they do not consider the method of tax collection, which we show is important in the ability to exploit inter-jurisdictional differences in tax rates.

The rest of the paper proceeds as follows. Section 2 analyzes a model of the evasion decision and describes under what circumstances statutory incidence alters economic incidence. Section 3 provides relevant institutional details. Section 4 describes the data, methodology and results. Section 5 concludes.

2   Incidence and Point of Taxation in Theory

Standard models of tax incidence treat compliance and monitoring as costless activities, which is a simplification that in many circumstances does not hold and could have important implications for the distribution of the burden of taxation. To see this, consider the demand and supply sides of a market, where these can either be thought of as consumers and firms, or alternatively two different levels of a supply chain. In equilibrium, price equates demand and supply: $D(p) = S(p)$. Introducing a quantity tax that must be remitted by suppliers alters this equilibrium to $D(p') = S(p' - t)$, where p' denotes the price paid by consumers. Alternatively, a similar tax that is instead remitted by the demand side of the market results in an equilibrium price p'' such that $D(p'' + t) = S(p'')$. The quantity sold and the pattern of net-of-tax prices must be the same in these two equilibria, where $p'' + t = p'$.

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[3]A related study by Besley and Rosen (1998) considers externalities between federal and state jurisdictions in setting excise taxes.

This irrelevance result is driven by demand and supply depending only on the tax-inclusive price. Allowing for differences in either the evasion technology or the cost of monitoring across the demand and supply sides of the market potentially alters this conclusion. Following Slemrod (2008), to generalize the standard model consider an evasion technology, x, for the demand side and y for the supply side. If the evasion technology enters into either the demand or supply functions, then the equilibrium net-of-tax prices may depend on the side of the market taxed. Collecting from the supply side yields an equilibrium price p' such that $D(p') = S(p', t, y)$, while a tax on the demand side yields an equilibrium price, p'', where $D(p'', t, x) = S(p'')$. The irrelevance law will hold only when x and y are symmetric for demand and supply, respectively.

2.1 Pass-through and Evasion with a Two-stage Supply Chain

We now adopt this idea to a supply chain with asymmetric market power. Consider a two-stage supply chain where a wholesaler with market power supplies identical perfectly competitive retailers. The wholesaler faces constant marginal costs of procurement c_w, fixed costs F_w and resells the product at wholesale price p_w. The retailers face variable costs that scale with size, $c_r(q_r)$, where q_r is the amount that each retailer sells with fixed costs F_r. Aggregate demand is given by $Q(p_r)$ where p_r denotes the tax-inclusive price charged by retailers to final consumers.

The government levies a quantity tax of t_w cents per gallon on wholesalers and a quantity tax of t_r on retailers. Firms required to remit the tax can evade using evasion technology specific to the point in the supply chain.[4] We denote the quantity of evasion for the retailer and wholesaler as e_r and e_w respectively. The private costs of evasion differ for a wholesaler and retailer and are functions of both the amount of evasion and the total quantity produced by a firm. These functions, $\phi_r(e_r, q_r)$ and $\phi_w(e_w, Q(p_r))$, reflect the resources expended in concealing tax liabilities and the expected value of penalties assessed by the tax authority.[5] Furthermore, the evasion technology may also reflect differences in the ability of tax authorities to monitor remittances at different points in the supply chain. Throughout the model, we maintain the assumption that the marginal cost of evasion is positive and increasing in the quantity evaded. We discuss later the relevance of how the marginal cost depends on the true quantity.

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[4]We assume no coordination between the wholesaler and retailer with respect to evasion. Only the firm(s) responsible for remitting the tax can engage in evasion.

[5]The distinction between resource cost and penalties is important if conducting a full accounting of the welfare effects of evasion, but for the purpose of analyzing the effect of taxes on retail prices the nature of the cost of evasion is not important. Also, we assume that firms are risk-neutral. The nature of penalties implies uncertainty in the returns to evading the tax. If one were to allow for risk aversion, it would become necessary to distinguish penalties explicitly.

2.2 Retailer Decision

For expositional simplicity, we focus on a specific case where: (1) all firms evade at an interior solution, and (2) the cost of evasion is independent of the total quantity produced by the firm.

Profits of the retailer and wholesaler are given by:

$$\Pi_r = (p_r - p_w - t_r)q_r - c_r(q_r) + t_r e_r - \phi_r(e_r) - F_r \tag{1}$$

$$\Pi_w = (p_w - c_w - t_w)Q(p_r) + t_w e_w - \phi_w(e_w) - F_w \tag{2}$$

Solving for optimal behavior by the retailers, we have:

$$q_r^* = c_r'^{-1}(p_r - p_w - t_r) \tag{3}$$

$$e_r^* = \phi_r'^{-1}(t_r) \tag{4}$$

Notably the quantity produced does not directly depend on the evasion technology available to the firm - at an interior solution, evasion is inframarginal to the production decision. If the number of firms is constant, this implies that incidence does not depend on the cost of evasion. With free entry this is no longer the case. Retailers earn surplus from evading taxes which induces entry and generates a relationship between industry supply and the retailer's evasion technology. Firms have no incentive to enter or exit when

$$\Pi_r = (p_r - p_w - t_r)q_r^* - c_r(q_r^*) + t_r e_r^* - \phi_r(e_r^*) - F_r = 0 \tag{5}$$

Differentiating (5) and applying the envelope theorem, we obtain expressions for how the tax-inclusive retail price, p_r responds to the taxes remitted retailers and the wholesaler, the wholesale price and the marginal cost of wholesale procurement:

$$\frac{\partial \Pi_r}{\partial t_r}|_{q_r^*, e_r^*} = \left(\frac{\partial p_r}{\partial t_r} - \frac{\partial p_w}{\partial t_r} - 1\right) q_r^* + e_r^* = 0 \tag{6}$$

$$\frac{\partial \Pi_r}{\partial t_w}|_{q_r^*, e_r^*} = \left(\frac{\partial p_r}{\partial t_w} - \frac{\partial p_w}{\partial t_w}\right) q_r^* = 0 \tag{7}$$

$$\frac{\partial \Pi_r}{\partial p_w}|_{q_r^*, e_r^*} = \left(\frac{\partial p_r}{\partial p_w} - 1\right) q_r^* = 0 \tag{8}$$

$$\frac{\partial \Pi_r}{\partial c_w}|_{q_r^*, e_r^*} = \left(\frac{\partial p_r}{\partial c_w} - \frac{\partial p_w}{\partial c_w}\right) q_r^* = 0 \tag{9}$$

The first two conditions imply that with entry, the retail margin responds differently to taxes levied on the retailers and taxes levied on upstream wholesalers. Reducing (6), an increase in

taxes levied on retailers is partially borne by the retailers themselves.

$$\left(\frac{\partial p_r}{\partial t_r} - \frac{\partial p_w}{\partial t_r}\right) = \frac{q_r^* - e_r^*}{q_r^*} \tag{10}$$

If the taxes levied on retailers rise, rents from retailer tax evasion accrue. Free entry dissipates these rents by reducing the retail margin on legally-remitted gallons. As the cost of tax evasion rises, e_r^* declines and the expression converges to one, which corresponds to the free-entry equilibrium without evasion. As the cost of evasion falls, the compensatory adjustment of retail margins lead to lower rates of pass-through.

In contrast, a tax levied on wholesalers affects retail and wholesale prices identically.

$$\left(\frac{\partial p_r}{\partial t_w} - \frac{\partial p_w}{\partial t_w}\right) = 0 \tag{11}$$

A tax levied on wholesalers does not affect the evasion rents earned by retailers - and consequently, free entry does not dissipate the illicit rents by adjusting the gap between retail and wholesale prices.

The second two conditions relate the wholesale price and the wholesale cost level to the difference between the retail and wholesale prices. Neither p_w or c_w affect evasion rents. Consequently, entry (or exit) leads p_r to adjust commensurately to changes in p_w or c_w, $\frac{\partial p_r}{\partial p_w} = 1$ and $\frac{\partial p_r}{\partial c_w} = \frac{\partial p_w}{\partial c_w}$.

2.3 Wholesaler Decision

Accounting for the behavior of the retailer, the wholesaler chooses p_w (and implicitly p_r) to maximize Π_w. Taking the derivative with respect to p_w we have

$$\frac{\partial \Pi_w}{\partial q_w} = Q(p_r) + (p_w - c_w - t_w)\frac{\partial Q}{\partial p_r}\frac{\partial p_r}{\partial p_w} = 0. \tag{12}$$

Substituting in the first-order condition for the retailer profits with respect to q_r, the profit maximizing choice of p_r^* is the solution to a variation on the traditional Lerner Index:

$$\frac{p_r^* - t_w - t_r - c_r'(q_r^*) - c_w}{p_r^*} = \frac{-1}{\epsilon_d}. \tag{13}$$

The expression equates the percentage wholesale markup above the retail price with the inverse demand elasticity. The profit maximizing retail price is a function of the elasticity of the demand curve and the collective marginal cost through all the stages of the supply chain,

$t_w + t_r + c'_r(q_r^*) - c_w)$.

Since the absolute rate of pass-through depends on the shape of the demand curve, it is instructive to consider the relative pass-through rates of taxes and changes in the wholesaler's cost of procurement, c_w. Denote the derivative of p_r^* with respect to c_w as α. Taking the derivatives of p_r^* with respect to t_r and t_w, we have

$$\frac{\partial p_r^*}{\partial t_r} = \alpha \left(1 + c''_r(q_r^*)\frac{\partial q_r^*}{\partial t_r} \right), \tag{14}$$

$$\frac{\partial p_r^*}{\partial t_w} = \alpha \left(1 + c''_r(q_r^*)\frac{\partial q_r^*}{\partial t_w} \right) \tag{15}$$

Taking the derivative of the retailer's FOC with respect to taxes remitted by retailers and the wholesaler, we can further simplify the relationships between the retail price and taxes as:

$$\frac{\partial p_r^*}{\partial t_r} = \alpha \left(\frac{q_r^* - e_r^*}{q_r^*} \right); \qquad \frac{\partial p_r^*}{\partial t_w} = \alpha \tag{16}$$

Taxes remitted by the retailer reduce the retail margin on legal sales of the good, while taxes remitted by the wholesaler do not. Consequently, wholesaler-remitted taxes are passed through at a higher rate to consumers. Pass-through of retailer remitted taxes depends on the degree of evasion in the retail market. Absent retail market evasion, taxes no longer affect the retail margin and the pass-through of taxes remitted by wholesalers and retailers is identical.

The preceding analysis suggests several factors that may lead the identity of the remitting party to affect pass-through. First, if evasion technology varies at different points in the supply chain, shifting remittance from a part of the supply chain with low costs of evasion to one with higher costs of evasion will tend to increase tax pass-through to consumers. Second, the cost of enforcement may differ. If the ease of enforcement varies, either due to firm size, concentration or detection technology, shifting remittance to a point where enforcement is less costly will tend to increase tax pass-through to consumers. More generally, policies that increase the private cost of evasion will tend to increase pass-through. Finally, entry plays an important role in pass-through in markets with tax evasion. Specifically, ease of entry at the point of remittance tends to lower pass-through to consumers. When taxes rise (and the rents associate with evasion increase), entry drives down legal margins to offset the increase in illicit rents. Where barriers to entry exist, the compensatory adjustment of the margin for legal sales may be constrained and firms may keep the tax wedge as excess profits.

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2.4 Evasion cost and firm size

Finally, we relax the condition that the private cost of evasion is independent of the size of the firm. The impact that relaxing this assumption has on firm supply depends on the extent to which the presence of costly evasion provides a penalty or a subsidy to increasing production.

We first consider the retailer's decision - consider private costs of evasion of $\phi_r(e_r, q_r)$.

Again, suppose the firm is at an interior solution, and denote the solutions to the retailer choice of evasion as $e_r^*(t_r, q_r)$. Differentiating profit with respect to q and noting that the optimal choice of evasion equates the retailer's marginal cost of evasion and tax rate, we can express the first order condition with respect to total quantity as:

$$p_r - p_w - t_r - c_r'(q_r) - \frac{\partial \phi_r(e_r, q_r)}{\partial q_r} = 0 \tag{17}$$

When choosing quantity, the firm equates the marginal revenue associated with selling an additional unit against the wholesale cost, retailer remitted taxes, the marginal cost of production, and the marginal private cost of evasion induced by an increase in quantity. Differentiating quantity q with respect to the tax rate relates the response of quantity supplied to the tax can depend on the evasion technology:

$$\frac{dq}{dt} = \frac{\phi_{11}\left(\frac{e_r*}{q_r*}\right) + \phi_{12}}{\phi_{12}^2 - \phi_{11}(C''(q) + \phi_{22})} \tag{18}$$

where ϕ_{11}, ϕ_{12}, and ϕ_{22} represent the second derivatives of $\phi_r(e, q)$. It is reasonable to assume that the marginal cost of evasion is increasing in the amount evaded, i.e. $\phi_{11} > 0$. However, the sign of the other components related to evasion in equation (18) are not clear. For instance, if $\phi_{12} > 0$, or in other words if larger firms face a greater marginal cost of evasion, then quantity supplied by retailers could actually rise when the tax increases.

3 Institutional Details

3.1 The Diesel Supply Chain and Tax Remittance

Crude oil is distilled into its constituent products at oil refineries. After the distillation process, No. 2 distillate, the general term describing diesel fuel, is further processed to meet regulatory standards dictating sulfur content, which differs depending on location of eventual sale, season,

and intended use.[6] The final product is held by prime suppliers at bulk terminals. There it is purchased by regional wholesale distributors, sometimes called "jobbers," for eventual delivery to retail outlets or directly to larger-scale end-users such as trucking companies. No. 2 distillate for use in home heating and industrial processes is referred to as fuel oil, while that used in vehicles is referred to as diesel. The two types are chemically equivalent other than the potentially different regulated sulfur content.

Diesel intended for highway use is subject to federal taxes of 18.4 cents per gallon and state taxes that currently range from 8 to 35.1 cents per gallon. Federal fuel taxes are the primary source of revenue for the Federal Highway Trust, which funds infrastructure investment.

Over time, the responsibility for the remittance of federal taxes has moved up the supply chain. Federal tax collection traditionally occurred at the retail level. In 1988, the point of taxation was moved to the wholesale distributor level, and in 1994 the responsibility for remittance was shifted again to its current location at the prime supplier level. There has also been considerable variation in the point of collection for state diesel taxes, both across states and over time, which we exploit in our empirical analysis that follows.

3.2 Opportunities for Evasion and Avoidance

Several characteristics of the market for diesel and the method of tax collection affect the opportunities for tax evasion and therefore how remittance can impact tax incidence. With a few exceptions, evasion can generally be grouped into one of three categories: the misreporting of the intended use of fuel, not remitting owed taxes, and bootlegging.

3.2.1 Misreporting the intended use

While diesel for highway use is subject to state and federal taxes, it is untaxed at either level if used for home heating, industrial processes, or in agricultural vehicles. The differential tax treatment of diesel depending on use creates a significant opportunity for wholesalers and prime suppliers to engage in tax evasion. Because both taxable and non-taxable uses are significant sources of demand for diesel,[7] the firm responsible for tax remittance may be able to credibly misreport the sale of a gallon of diesel as being for an untaxed use.

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[6]From October 1993 to August 2006, the allowable sulfur content for on-highway diesel fuel was 500 parts per million (ppm). Federal regulations did not constrain the sulfur content of diesel intended for other uses. Beginning September 1, 2006, the EPA began phasing in Ultra Low Sulfur Diesel Fuel requirements, requiring that sulfur content not exceed 15 ppm. By 2010 all diesel sold for on-highway use met this standard. Non-road diesel was required to move to 500 ppm in 2007, and the 15 ppm standard is currently being phased in.

[7]According to data from the Energy Information Administration, in 2004, 59.6 percent of distillate sales to end users were retail sales for on-highway use.

Beginning in October 1993, terminals were required to add red dye to diesel fuel sold for untaxed off-highway use. This allowed for a simple visual inspection to verify that taxes had been paid on a particular gallon – a truck with red diesel in its gas tank was evading taxes. As documented by Marion and Muehlegger (2008), the dyeing regime led to a substantial improvement in tax compliance. Reported sales of diesel for use on-highway rose by 25-30 percent, with a corresponding decline in reported sales for untaxed uses. This startling impact on compliance suggests that, at least pre-1993, there was substantial evasion by misreporting use.[8]

The misreporting of the intended use is likely to be a particular problem when the point of taxation is above the retail station, as untaxed uses are not typically distributed via retail outlets, with the exception of some agricultural sales. This may help explain why the federal point of taxation was moved to the terminal level only after the dye program was instituted, as this type of evasion became relatively less important.

3.2.2 Failure to remit

A second form of evasion involves an incurred tax liability being incurred that is not remitted to the government. This is most likely to occur at the retailer or distributor level. Simple underreporting is one possible issue. Another classic example is the "daisy chain," which is sometimes observed when the distributor is responsible for remitting the tax. Under this scheme a gallon of diesel is sold by the prime supplier to the wholesale distributor, who then sells it to other dummy distributors in a series of (likely paper-only) transactions. At some point the gallon is sold to a retail station, and the party responsible for remitting the tax "disappears."

Moving the point of taxation up the supply chain reduces the number of parties with a tax liability. According to the Internal Revenue Service, there are 1,343 active bulk fuel terminals in the United States, compared with around 855,915 retail gasoline station establishments reported in the County Business Patterns. Monitoring and identifying underpayment of tax liabilities is therefore thought by tax enforcement authorities to substantially easier when the tax is remitted by parties higher in the supply chain, simply by virtue of there being fewer parties to monitor. (Baluch, 1996)

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[8]Although the dye program was initially highly successful at curtailing this form of evasion, several new techniques have been employed by evaders to skirt the dyeing regulations. In particular, evaders have been found offloading fuel without injecting dye, removing dye from the fuel, and/or masking the dye's color. Also, misreporting the fuel's intended use may still be an issue in some circumstances, as states allow for refunds of the tax remitted if the user later claims the fuel was used for untaxed purchases. This is often true in agriculture uses.

3.2.3 Interjurisdictional evasion

A third type of evasion exploits differential rates of taxation across different jurisdictions. Bootlegging is one example, where purchases are made by a distributor in a low-tax state, and then sold to retailers in a neighboring high-tax state at a higher price that reflects the tax rate in place. A second example involves a distributor that purchases fuel from a supplier claiming it is intended for export to another state and thereby not subject to the state tax. Rather than exporting, the firm then sells it to a within-state retail station.

Interjurisdictional evasion also arises through Native American reservations in a variety of ways. Due to the sovereignty of the reservations, foreign imports to a reservation are not tracked by the federal government or state governments. Imported gallons can then be diverted to retail stations outside the reservation.

Finally, it is also possible to illicitly import untaxed fuel from abroad, subsequently selling the fuel to retail stations. Each of these interjurisdictional methods for evasion are eliminated if the point of collection is the retail station.

3.2.4 Implications for pass-through

In the context of diesel taxation, the theoretical model and institutional details suggest that tax pass-through should be greater when the remitting party is upstream rather than downstream. Especially since the dyeing regime was instituted, most of the opportunities for evasion exist downstream of the wholesale terminal, at either the distributor or retailer level. Moreover, wholesale operations tend to be larger and more concentrated than distributor or retail operations - wholesalers are typically major oil brands with operations in many states, while retail stations are numerous and ownership is much less concentrated. If detection of illegal activity is easier or close scrutiny less costly, evasion opportunities at the wholesale terminal may be further curtailed. Finally, opportunities for entry likely differ. Entry and exit are relatively easy at the distributor and retail level relative to at the terminal level, where entry may face constraints related to permitting and siting, which means that rents from evasion are less likely to be competed away at the prime supplier level. All three would tend to increase pass-through of a tax remitted by terminal owners relative to a tax remitted further downstream.

4 Data and Methodology

To this point we have argued that the pass-through rate of a tax to the retail price can, in a setting where evasion is important, depend on the location of tax remittance responsibility. We now proceed to examine the evidence for this hypothesis in the diesel fuel market.

4.1 Data

We collected data on the point of tax collection from successive annual issues of "Highway Taxes and Fees: How They Are Collected and Distributed," published by the Federal Highway Adminstration. For each state and year, the Federal Highway Administration contacts state tax authorities and collects data on the point of collection for diesel and gasoline taxes.

In Figure 1, we display the variation in the point of taxation over time. In the mid-eighties, the majority of states collected taxes from distributors. At the beginning of our sample in 1986, distributors were responsible for remittance in 37 states, with the balance of states collecting from retailers. The early nineties saw a trend toward collecting taxes from higher points in the supply chain, in particular from the prime supplier. In January 1993, Michigan became the first state to do so, and by the end of 2006 twenty states collected taxes from prime suppliers. While a plurality of states still collect from wholesale distributors, the practice of collecting from retailers has been almost entirely phased out, with only New Jersey and Oregon collecting tax from retailers at the end of our sample in 2006.[9]

In Figure 2, we present a map of the variation in the point of tax collection across states for 1990, 1997, and 2004. In 1990, the entire eastern section of the U.S. collected taxes from the distributor. The collection of taxes at the retail level was concentrated in Midwestern and Western states. Panels B and C describe the geographic characteristics of the transition to taxing at higher levels of the supply chain. During this time, the West, Midwest, and mid-Atlantic transitioned largely toward collecting diesel taxes from terminal operators. Collection at the distributor level was concentrated in the northeast, south, and mountain states. An interesting observation from this figure is that the point-of-collection policy seems to be spatially correlated, which suggests that there are spillovers of some kind across states in tax collection.

In Table 1, we further describe the nature of the variation in tax collection by showing the matrix of changes in point of collection. We observe 29 changes in the point of tax collection, of which 28 are upstream. Eight of these are changes from retailer collection to distributor

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[9]Oregon is a special case. There, diesel used for trucking is not taxed directly, and instead a levy on weight-miles driven within the state is collected. Given the importance of trucking in the diesel market, we will in general exclude Oregon from the analysis.

collection, five are retailer to supplier shifts, and fifteen are distributor to supplier shifts. In only one instance did a state move the point of collection down the supply chain, in this case from collecting at the distributor level to collecting from retail outlets.

Several diesel price series are available at the state level from the Energy Information Administration (EIA). The EIA collects diesel prices for select states, mostly comprising states in the Northeast, Mid-Atlantic, Upper Midwest and a handful of Northwestern states with relatively high use of home heating oil. Beginning in 1983, the EIA reports an average price of No. 2 distillate, which includes taxed diesel fuel, untaxed diesel fuel, and heating oil. It distinguishes between diesel sold through retail outlets and that sold for resale. However, the resale price can include sales by prime suppliers to local distributors, or from local distributors to retail stations, which will pose a disadvantage in assessing how tax collection affects how retail stations share the tax burden with distributors, or distributors with prime suppliers'. Furthermore, prior to 1994, the resale price of No. 2 distillate also included untaxed sales of diesel.

From 1994 on, the EIA also reports the average retail and resale prices specifically of No. 2 diesel. This distinction is irrelevant for sales through retail outlets, as only diesel fuel is sold through retail outlets. During the period of time where the series overlap (from 1994 on), the retail prices for No. 2 distillate and diesel fuel are identical. On the other hand, resale of No. 2 distillate can include transactions for on-highway diesel, heating oil, or other uses of distillate. Therefore, the series describing the resale prices of No. 2 distillate and No. 2 diesel are not perfect substitutes. The two series move in lock-step ($\rho = 0.994$), but the resale price for No. 2 distillate averages 1.4 cpg less than the resale price for diesel fuel. For these reasons, we focus our attention in this paper on the retail price of No. 2 diesel.

We have argued that how remittance affects incidence depends on its effect on tax evasion opportunities. To measure how tax remittance may affect tax collection and evasion opportunities, we also obtain data on the quantity of diesel sales from two separate sources. The most accurate measure of diesel tax collections comes from the Federal Highway Administration, which reports in the Highway Statistics Annual, Table MF-2, the annual quantity by state of special fuels on which taxes were collected. Taxed special fuels are almost entirely diesel fuel. Beginning in 1983, the EIA also reports monthly data from a survey of prime suppliers, who distinguish sales of No. 2 diesel and heating oil by state. What level of the supply chain the EIA treats as the prime supplier for the purposes of reporting depends on whether the fuel is imported from another jurisdiction. For fuel distilled in the state of eventual sale to the end user, the prime supplier is the bulk terminal. For distilled fuel imported from another state or

country, the prime supplier is considered to be the first distributor within the state who receives the fuel. We obtain information about the federal and state on-road diesel tax rates from 1981 to 2006 from the Federal Highway Administration Annual Highway Statistics.

We also collect data on state-level covariates. Population, per capita income and mean family size are obtained from the Census Bureau. Urbanization and educational attainment are taken from the Bureau of Economic Analysis. Information about drivers, vehicle registration, and vehicle usage are from successive issues of Highway Statistics produced by the Federal Highway Adminstration.

We recognize that it is unlikely that the choice of the point of taxation is chosen randomly. To investigate this issue, in Table 2 we present the mean differences of a variety of demographic characteristics between retailer, distributor, and supplier- remitting states. Each column in a particular panel shows a regression of the stated variable on distributor and supplier-remit dummies, as well as year fixed effects.[10] The results shown in Table 2 suggest that the point of taxation is correlated with few of the covariates. Compared with retailer-remitting states, those that tax at the supplier level tend to have a less-educated adult population and are less conservative politically. Those taxing at the distributor level also have a somewhat less educated population than retailer-remitting states, and have a smaller budget surplus, and both the upper and lower state houses have a have slightly higher portion of Democrats. Income, unemployment, population, urbanization, family size, and vehicle miles traveled per capita are all similar between the three collection regimes.

We also conduct two other exercises examining the potential endogeneity of remittance policy. First, in Table 3 we examine whether states that change the point of collection at some point in the sample are different than those who leave the point of collection unchanged. Only a state's mining share of Gross State Product and the conservative-values score of the state house of representatives are significant at the 10 percent level.

Second, we wish to consider which covariates may be contemporaneously correlated with changes in either the point of tax collection or the diesel tax. In four separate specifications, we regress the change in the distributor-remit, retailer-remit, and supplier-remit dummy variables, and the change in the state diesel tax, on a set of covariates. The results are presented in Table 4. As with the results shown in Table 2, few variables are correlated with changes in the tax regime. Population is positively related with a change in supplier remittance, though negatively

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[10]Many of the variables in this table are not included in the set of covariates in the regression specifications later, as variables such as population, average family size, percent of population that are BA graduates will be slow-moving, and most of their variation will be captured by state fixed effects.

correlated with a change in distributor remittance. An increase in the fraction of adults with a college degree is associated with less likelihood of moving the point of collection to the supplier level. A greater share of high school graduates is associated with a lower likelihood of taxing at the distributor and a greater likelihood of moving the point of collection to the prime supplier. Increases in gross state product are associated with relative declines in the state diesel tax. Also, average family size and the fraction of adults with a high school degree are negatively associated with the tax rate. All in all, we find no evidence of systematic determinants of changes in tax regimes, but of course we cannot rule out decisively that there are unmeasured determinants.

4.2   Methodology

4.2.1   Point of taxation and incidence

We examine the degree to which diesel taxes are passed through to retail prices using variation across states and over time in state diesel tax rates and the point of tax collection. Ideally, we would observe the price charged by bulk terminals to wholesale distributors, and by wholesale distributors to retail stations; this would allow for a direct evaluation of the burden of taxation across different levels of the supply chain. Unfortunately, data limitations preclude this level of analysis, and so we must rely on an analysis of retail prices, which we argue reflects changes in incidence higher up the supply chain. For instance, if changing the point of tax collection raises the price that wholesalers charge retailers, then this higher cost for retailers will be reflected in the price they charge to consumers.

To be specific, we estimate a specification of monthly real tax-exclusive retail diesel prices, deflated using the consumer price index.

$$p_{it} = \beta_0 + \beta_1 \tau_{it} + \beta_2 regime_{it} + \beta_3 \tau_{it} * regime_{it} + BX_{it} + \epsilon_{it} \tag{19}$$

where $regime_{it}$ represents the indicator variables for the point-of-collection regime employed by state i in month t, and X_{it} is a vector of covariates including state economic conditions, state and year*month effects, the minimum of the tax rates in neighboring states, and the portion of households who use fuel oil for home heating, interacted with heating degree days.

One extension to the primary specification given by (19) we pursue is to allow for the coefficients in the model to vary over time. It is possible that the elasticity of demand for diesel fuel changes over time in an unobservable way, which would alter the predicted degree of pass-through. Because the point of collection has on average moved up the supply chain over

time, this could lead us to mistakenly attribute changes in incidence to the point of taxation that are actually due to shifts in demand elasticity. Similarly, changes in regulations or refinery capacity over time could alter the supply elasticity in a manner correlated with trends in the point of taxation. To correct for this, we will also estimate a version of (19) that allows for a time varying value of β_1 by controlling for a full set of year-tax interactions.

4.2.2 Remittance, evasion, and tax collections

We next use the data on taxed quantities from the FHWA to evaluate the impact of point of tax collection on tax evasion. If changing the point of tax collection affects evasion, then ceteris paribus tax collections should change as more or less taxable gallons are reported.

We examine the contemporaneous correlation between three types of regime changes and the change in taxed gallons. In particular, we estimate an equation of the form

$$\Delta ln(q_{it}) = \alpha_0 + \alpha_1 \Delta ln(p_{it}) + \alpha_2 \Delta ln(1 + \tau_{it}/p_{it}) + \sum_j \alpha^j d_{it}^j + A\Delta X_{it} + \rho_t + \epsilon_{it}. \qquad (20)$$

where j indexes the three types of transitions witnessed in the data: retailer-to-distributor collection, retailer-to-supplier, and distributor-to-supplier. The dummy variable d_{it}^j indicates that transition j took place in state i in time t. We model the log of taxed gallons as a function of the log of the tax inclusive price, $ln(p+t)$. To separately identify the response of taxed gallons to the tax rate from the response to the price, we factor out the price from this expression. As stressed by Slemrod (2001), the parameter α_2 need not equal α_1. Kopczuk (2005) and Slemrod and Kopczuk (2002) point out that the size of the tax base as well as the degree of enforcement can both influence the elasticity of tax collections to the tax rate. As in the price specification, the vector of covariates in X_{it} includes state economic conditions, the tax rate in neighboring states, and the weather and its interaction with household use of fuel oil for home heating. The variable ρ_t represents common year effects.

To examine pre-existing differences between the different tax regimes, and to verify that any changes in tax collections correspond to the regime change, we will also examine graphically the coefficients β_{t-j}^k from the following regression:

$$ln(q_{it}) = \beta_0 + \sum_k \sum_{j=-2}^{2} \beta_{t-j}^k I(d_{i,t-j}^k) + \phi_t + \rho_i + \epsilon_{it}. \qquad (21)$$

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where k indexes the type of transition and $I(d_{i,t-j}^k)$ is an indicator for whether the type of transition k occurred in year $t - j$. This exercise will yield the average residual tax collections in the periods before and after each type of regime transition that we observe in the data.

5   Results

5.1   Tax Incidence Results

In this section, we present estimates of the effect of the point of tax collection on retail diesel prices. In Table 5, we show the results of estimating equation (19), where the dependent variable is the real retail price, excluding taxes. In column 1 of this table, we show the results of including only the diesel tax and control variables, and excluding any information about the party responsible for tax collection. The coefficient on the diesel tax variable suggests that the net-of-tax retail price falls 0.86 cents for every ten cent-increase in the diesel tax. The interpretation of this coefficient is that nearly all (91.4 percent) of the tax burden is born by consumers, and the amount suppliers received per gallon from consumers falls little as taxes rise. Other coefficients are similar to those found in Marion and Muehlegger (2011). Prices rise as the tax rate in neighboring states increase, and prices are higher in cold months where households tend to use diesel for home heating. Lastly, economic activity is correlated with prices, as the unemployment rate has a negative association with prices, likely due to reduced demand.

The specification shown in column 2 includes indicators for whether the state collects at the distributor level or at the bulk terminal. The excluded category are states collecting the diesel tax from retail outlets. Compared to states collecting at the retail level, states in which the party responsible for remitting the tax is the prime supplier have a retail price that is 2.88 cents higher, and those taxing the wholesale distributor have a retail price that is 1.38 cents higher. Both of these coefficients are consistent with the hypothesis that retail stations are difficult for tax authorities to monitor and that the relatively small number of bulk terminals make evasion more costly for these firms.

In column 3 of Table 5, we show the results of estimating a specification including interactions between the remittance regime dummy variables and the tax rate, which allows the pass-through rate of diesel taxes to prices to depend on the point of collection. The coefficients on the interaction between diesel taxes and the collect from the distributor and terminal indicators are 0.10 and 0.21, respectively; both are statistically different from zero, although the former is only marginally so (p-value=0.073). This suggests that the pass-through rate rises as the tax

collection point is moved up the supply chain. Furthermore, the pass-through rate is highest when collecting from the bulk terminal, as the coefficient on the interaction between the tax rate and the supplier collection dummy is higher than the coefficient on the similar interaction with the distributor collection dummy (p-value=0.081). This result is also consistent with the observation that the prime supplier is the easiest point in the supply chain to monitor.

It is worth noting that the sum of the main effect and the interaction in the case of taxing the bulk terminal leads to an estimated pass-through rate of greater than 100 percent. The estimates suggest that the *tax-inclusive* retail price rises by 1.089 cents for each 1-cent increase in the diesel tax. However, this is not statistically distinguishable from full pass-through (p=0.14), which is a reasonable baseline, as it is the upper bound of the pass-through rate in a competitive model without differential evasion opportunities.

Finally, the specification displayed in column 4 includes a full set of year by diesel tax interactions, which allows the rate of tax pass-through to vary over time. This is plausible due to the time trend in the point of taxation, and that factors that may influence the elasticity of supply and demand, such as environmental regulations and the demand for untaxed uses of diesel, may have shifted over time. It turns out, however, that allowing for time-varying pass-through rates has little effect on the estimated parameters of interest. The direct effect of the point of tax collection is small and indistinguishable from zero, and the interaction terms between the diesel tax and the indicators for the collection point being the terminal and the distributor are 0.16 and 0.14, respectively, very little changed from the primary specification.

5.1.1 Accounting for trends in pass-through

The above approach compares the pass-through rate in a state after a change in the point of collection with the pass-through rate prior to the shift. Therefore, unobserved characteristics affecting pass-through in a state that are fixed over time will not affect our results. However, our estimates will be biased if unobserved variables that alter rates of tax pass-through are moving over time in a way that is correlated with the change in tax collection regime. For instance, if the number of bulk terminals changes over time in a state, the tax authorities may find it more desirable to collect the tax from the prime supplier owing to the number of taxable agents. Such a change may also alter the rate of tax pass-through by changing the elasticity of supply with respect to price.

To address this concern, we exploit the timing of the change in remitting party. We account for trends in pass-through relative to the date of the regime change, examining whether pass-

through changed discontinuously at the date of the regime change. This is conceptually similar to a parametric regression discontinuity design, where the running variable is time, and the threshold is the date of the policy change.

We consider states that undertook a particular regime change, either shifting from retailer to distributor collection or from distributor to prime supplier.[11] We center the data such that the date of the state i's regime shift is t_i^0. We then estimate our standard pass-through specification, adding an interaction term $\tau_{it} * (t - t_i^0)$ as well as the direct effect $t - t_0^i$. This allows the estimated pass-through rate to differ in a linear fashion over time, and we can therefore examine the post-regime difference in pass-through relative to this trend.

We present the results in Table 7. Columns 1 and 2 contain estimates from estimating the pass-through equation for states moving the point of collection from the wholesale distributor to the prime supplier. Pass-through is greater after the move to the supplier level, as seen in column 1. Furthermore, the results in column 2 indicate that there is no trend in pass-through relative to the date of the regime change nor does including this interaction term alter the coefficient on the variable of interest. A similar story emerges when we examine retailer-to-distributor regime changes, as shown in columns 3 and 4. The pass-through rate is higher when the state requires the tax to be remitted by the distributor compared to when it requires the tax to be remitted by the retailer. Furthermore, this set of states do not experience a trend in incidence relative to the date of the regime change, nor does allowing for such a trend alter the primary coefficient of interest.

5.1.2 Price for resale

In this section we describe estimates of the effect of the point of collection on the wholesale price of diesel, and we examine how taxes work through to retail prices via the wholesale price when the tax is collected from the prime supplier. In column (1) of Table 6, we present estimates of our base incidence specification, with the real resale price as the dependent variable. We see that the price for resale is around two cents higher when the tax is collected from the prime supplier, and 0.7 cents higher when collected from the distributor level, compared to when the tax is collected at the retail level. On average, the tax has virtually no effect on the net of tax resale price. In the specification shown in column (2), we include the interaction between the tax and indicators for collecting from the distributor and the prime supplier. When the tax is

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[11]The other upstream transitions witnessed in the data are retailer-to-supplier, of which there have been five during our sample. We are unable to specifically use these in this exercise because we observe price for only two of these transitions.

collected from the prime supplier, an increase in the tax leads to an increase in the wholesale diesel tax. A ten cent per gallon tax increase leads to a 2.4 cent increase in the resale price in supplier remitting states relative to retailer remitting states. Conversely, tax changes have virtually no effect on the resale price in distributor remitting states or retailer remitting states. This will be true if sales by prime suppliers make up the bulk of the sales used to calculate the price of diesel for resale.

We are able to show what implications this has for retail price incidence. In column (3) of Table 6, we restate the results of column (3) of Table 5, which shows that a ten cent tax increases the retail price by 2.1 cents in a supplier remitting state relative to a similar tax change in a retailer remitting state. In column (4), we show the results of estimating a similar specification, where we also include as control variables the concurrent and lagged price of diesel for resale. Controlling for resale price, the coefficient on the tax*supplier remittor interaction is now small and statistically insignificant. This suggests that the differential effect of tax on retail prices in supplier remitting states is entirely explained by the effect on the wholesale price, just as one would expect if our results are valid.

This narrows down the set of alternative explanations for our results. For the relationship between pass-through and tax collection regime to be explained by changes in unobserved variables, they must be ones that affect the resale price alone and have no independent effect on the retail price of diesel.

5.2 Tax Collection Results

We now examine how the level of taxed gallons responds to the point of taxation. As the state adjusts the point of tax collection, we interpret corresponding observed changes in tax collections as evidence of a change in tax compliance. This will provide a link between the empirical results discussed in section 5.1 and the theoretical predictions in Section 2.

In Table 8, we present estimates of equation (20), which relates changes in taxed gallons to specific changes in the point of tax collection. The specification shown in column (1) includes only the variables indicating the stated shift in regime. Upstream shifts in the point of collection are associated with a higher reported tax base. A change in the point of taxation from the retailer to the distributor is associated with similar improvements in collections as retailer to supplier changes, with the former yielding a 7.3 percent improvement in collections (p-value=0.102) while the latter yields a 7.8 percent improvement (p-value=0.050). When the point of remittance is moved from the distributor to the prime supplier, tax collections rise by only 1.5 percent, an

estimated effect that is not statistically distinguishable from zero.

In Column 2, we display results of a specification with a variety of covariates, including log price, the log tax rate, state macroeconomic conditions as captured by log GSP and unemployment, weather, and and home heating use. The estimated effects of the three types of tax collection regime changes are virtually unchanged, which is not surprising in light of the fact that none of these variables are correlated, at least contemporaneously, with states' decisions regarding where in the supply chain to collect the tax.

Lastly, the specification shown in column (3) includes a control for the lagged dependent variable. The lagged change in taxed gallons is significantly negatively correlated with the current change in taxed gallons. The data suggest that this is likely to be a reporting phenomenon, as states will at times have unusually high (low) reported tax collections in one year, followed by unusually low (high) reported tax collections the next year. Regardless, the coefficients of interest are unaltered by the inclusion of this variable.

Because they are estimated in first-differences, the regression results capture the contemporaneous response of tax collections to changes in the point of tax collection. We can further explore the timing of the response of tax collections to the change in the collection regime, as well as consider any pre- or post-change trends in tax collections. In Figure 3, we plot the average residual taxed gallons, taking out year and state effects, in each year from two years before the change in the collection regime to two years after.

Compared to states that move the point of collection from the distributor to the supplier, and hence are already collecting the tax above the retail level, tax collections are initially lower in states who move the point of collection away from the retail level. This is true regardless of whether the state will ultimately move the collection point to the distributor or the prime supplier. As suggested by the regression results presented in Table 8, states moving the point of collection away from the retailer experience a jump in collections in the year of the policy change. Importantly, average tax collections were similar in all three cases after the change in collection regime. Despite the fact that states that initially collected from the distributor had tax collections around 3 percent higher, the average of the post-reform coefficients for each of the three types of regime changes are within 0.7 percent of one another.

6 Conclusion

The independence between equilibrium tax-inclusive prices and the side of the market taxed is a widely accepted "law" of tax incidence and is a key principle a student of public finance

learns in the study of tax theory. This paper presents the first estimates of how prices may in fact respond to the identity of the tax remitter and provides evidence that the source of this result is variation in the ability to evade taxes between the two sides of a market. This result has potentially important implications in understanding the distributional impact of taxation in markets where evasion is prevalent.

Our results are directly applicable to the current debate on whether carbon taxes should be levied on upstream energy producers or downstream energy users. The current literature weights the administrative, political and distribution advantages and disadvantages of each, but largely ignores tax incidence, effectively assuming that the incidence of a carbon tax levied on energy producers and energy users would be identical. Although it is impossible to assess opportunities for outright evasion of a hypothetical carbon tax, a major part of the debate focuses on the ability of firms to avoid a carbon tax by increasing production in unregulated jurisdictions. If those opportunities differ substantially for energy producers and energy users, incidence may be affected by the point of remittance in a very similar way to the context we examine.

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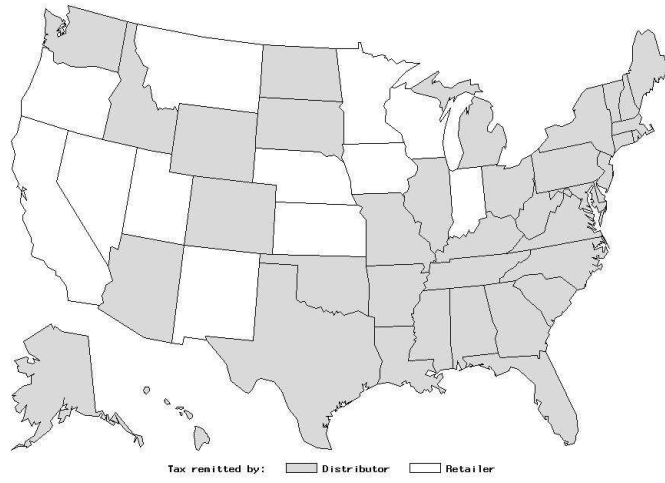[20] Kau, James B. and Paul H. Rubin. (1981) "The Size of Government," *Public Choice* 37:2, p. 261-274.

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Figure 1: Tax remittance liability over time

Figure 2: Tax Collection By State

Panel A: 1990

Tax remitted by: ☐ Distributor ☐ Retailer

Panel B: 1997

Tax remitted by: ☐ Distributor ☐ Retailer ☐ Terminal

Panel C: 2004

Tax remitted by: ☐ Distributor ☐ Retailer ☐ Terminal
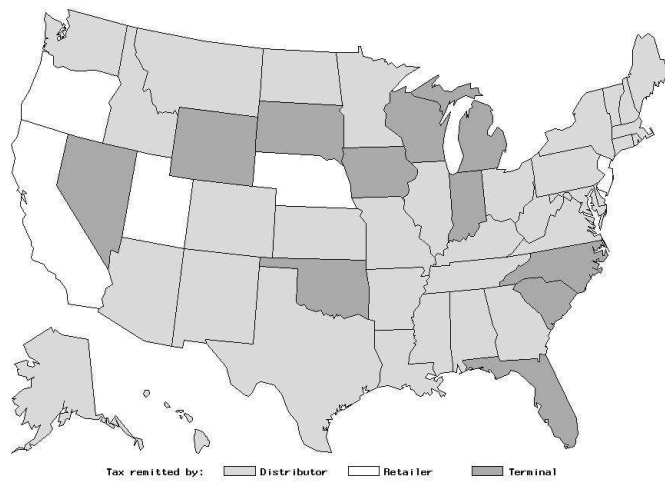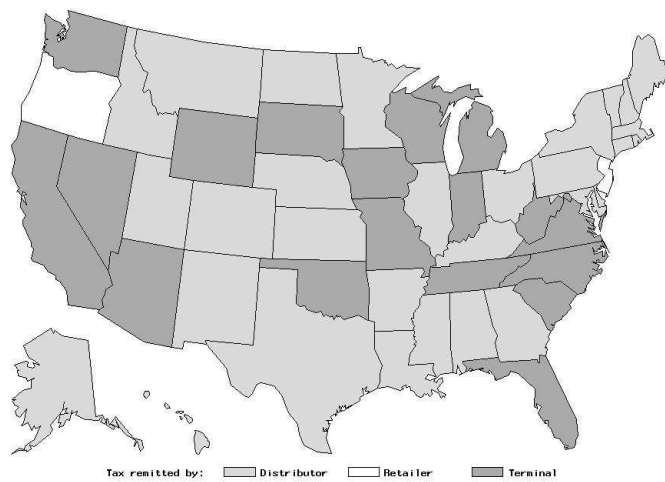
Figure 3: Collection regime shifts and taxed gallons

Average log taxed gallons of diesel by year relative to collection regime change. Year and state effects removed.
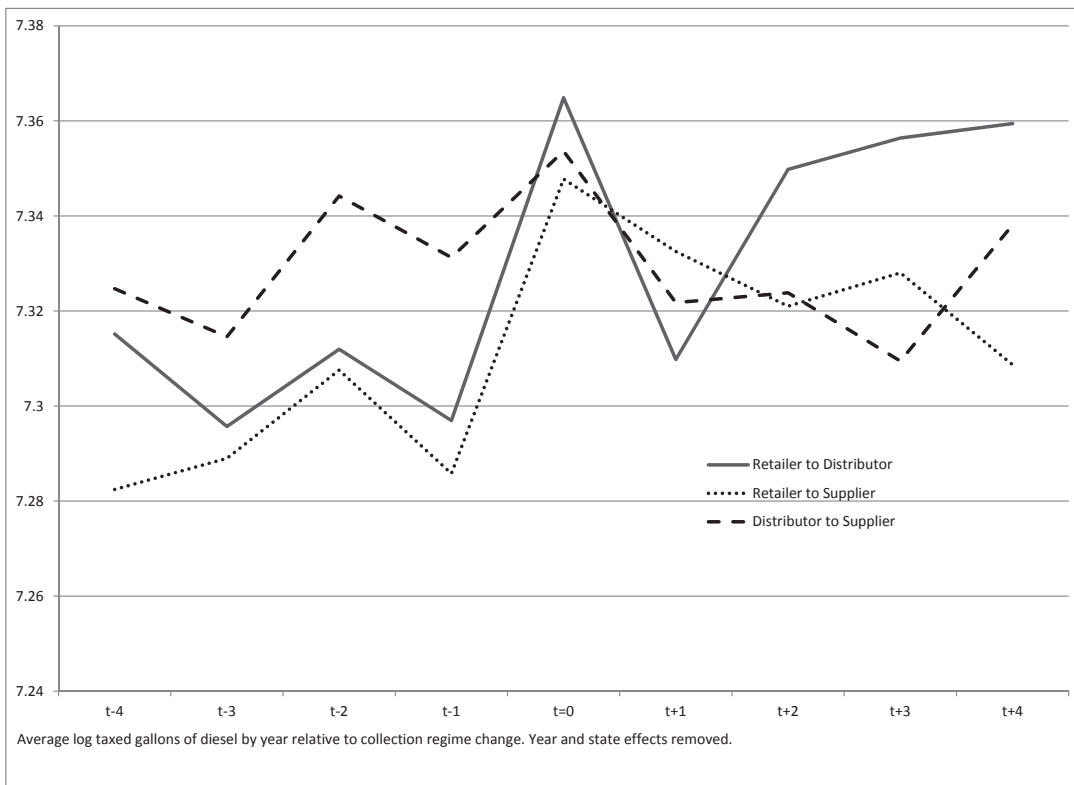
Table 1: Transitions in the point of tax collection

		To:		
		Retailer	Distributor	Supplier
	Retailer	-	8	5
From:	Distributor	1	-	15
	Supplier	0	0	-

Table 2: Demographics and the Point of Tax Collection

Panel A

	Tax-Exclusive Diesel Price ($/gal)	State Diesel Tax (cpg)	GSP per capita ($)	Unemployment Rate (%)	Manufacturing GSP Fraction	Mining GSP Fraction
Distributor Remit	2.965*	-0.829	-871.0	0.523	0.0111	0.0105
	(1.722)	(1.254)	(1170.7)	(0.369)	(0.0193)	(0.0103)
Supplier Remit	-1.612	-1.641	-1432.5	0.314	0.0398*	0.0138
	(2.469)	(1.705)	(1515.1)	(0.393)	(0.0219)	(0.0193)
Constant	133.3***	20.16***	30337.2***	4.889***	0.144***	0.0154**
	(1.596)	(1.138)	(1064.5)	(0.310)	(0.0166)	(0.00632)
Observations	6090	13536	13248	13536	13536	13536
R-Squared	0.990	0.207	0.709	0.311	0.198	0.0165

Panel B

	Adult Population	Urban Pop % of Total	Average Family Size	Percentage BA graduates	Percentage HS graduates	Vehicle Miles Per Capita
Distributor Remit	-0.940	-0.0347	-0.0994	-0.796	-4.086***	0.000430
	(1.843)	(0.0549)	(0.0735)	(1.006)	(1.181)	(0.000436)
Supplier Remit	0.486	-0.0291	-0.107	-3.522***	-4.056***	0.00124
	(1.413)	(0.0697)	(0.0848)	(0.884)	(1.432)	(0.000805)
Constant	4.686***	0.750***	3.257***	23.56***	83.07***	0.0128***
	(1.718)	(0.0485)	(0.0723)	(0.741)	(0.866)	(0.000394)
Observations	13248	13248	13248	13248	13248	13248
R-Squared	0.0205	0.00524	0.138	0.333	0.462	0.196

Panel C

	State Budget Surplus	Senator LCV Score	Representative LCV Score	Democrat Governor	Democrat Fraction State Senate	Democrat Fraction State House
Distributor Remit	-0.0284*	-5.872	-1.142	0.0316	0.100***	0.0804**
	(0.0147)	(7.455)	(5.586)	(0.126)	(0.0343)	(0.0334)
Supplier Remit	-0.0112	-8.150	-12.78*	0.191	0.0339	0.0190
	(0.0215)	(10.13)	(7.592)	(0.162)	(0.0392)	(0.0356)
Constant	0.113***	52.56***	48.23***	0.414***	0.476***	0.492***
	(0.0120)	(6.595)	(4.892)	(0.112)	(0.0258)	(0.0222)
Observations	12672	13248	13248	13440	13020	12984
R-Squared	0.475	0.0201	0.120	0.0539	0.132	0.105

Retailer-remittance is the omitted category. All regressions include year fixed effects. Standard errors clustered by state.

Table 3: Summary Statistics By Change in Point of Diesel Tax Collection

	Full Sample	States Not Changing POT	States Changing POT	Difference
Tax-Exclusive Diesel Price	95.97 (43.77)	97.88 (44.22)	93.20 (42.97)	-4.67*
State Diesel Tax	19.12 (5.026)	19.24 (5.278)	19.03 (4.828)	-0.21
GSP per capita	28153.9 (8784.1)	28392.8 (9560.0)	27983.3 (8181.5)	-409.5
Unemployment Rate (%)	5.307 (1.555)	5.255 (1.487)	5.346 (1.602)	0.091
Manufacturing Share of GSP	0.162 (0.0677)	0.166 (0.0640)	0.158 (0.0702)	-0.008
Mining Share of GSP	0.0235 (0.0499)	0.0103 (0.0241)	0.0333 (0.0607)	0.23*
Population (millions)	4.135 (4.377)	3.179 (2.776)	4.817 (5.120)	1.638
Urban Population Share	0.722 (0.188)	0.719 (0.194)	0.725 (0.183)	0.006
Family Size	3.184 (0.194)	3.143 (0.151)	3.213 (0.214)	0.071
Percent of Adults with BA	22.09 (4.755)	22.92 (5.483)	21.50 (4.055)	-1.42
Percent of Adults Graduating HS	79.30 (6.127)	79.12 (6.470)	79.44 (5.866)	0.31
Vehicle Miles Traveled Per Capita (000s)	13.2 (2.33)	12.9 (2.22)	13.4 (2.38)	0.5
Percent State Budget Surplus	0.0953 (0.109)	0.09 (0.105)	0.10 (0.112)	0.01
Senator LCV Score	46.96 (31.03)	51.87 (33.23)	43.45 (28.86)	-8.41
Rep LCV Score	44.58 (24.61)	53.15 (26.38)	38.47 (21.25)	-14.68**
Democrat Governor	0.457 (0.497)	0.484 (0.499)	0.437 (0.495)	-0.046
Democrat Fraction of State Senate	0.546 (0.168)	0.576 (0.183)	0.522 (0.152)	-0.054
Democrat Fraction of State House	0.546 (0.162)	0.568 (0.192)	0.528 (0.132)	-0.040

Standard errors for difference column clustered by state.

Table 4: Predictors of Tax Changes and Changes in Point of Taxation

	Δ Distributor Remit	Δ Retailer Remit	Δ Supplier Remit	Δ State Diesel Tax
		Dependent Variable:		
Retail Gasoline Price	-0.000729	-0.00316	0.00389	-0.00587
	(0.00221)	(0.00223)	(0.00298)	(0.0139)
GSP per capita	-0.00474	-0.00788	0.0126	-0.147**
	(0.00666)	(0.00605)	(0.00909)	(0.0555)
State Unemployment Rate	0.0159	-0.0101	-0.00578	0.0861
	(0.0132)	(0.00859)	(0.00958)	(0.0713)
Manufacturing Fraction GSP	0.307	-0.162	-0.145	3.722
	(0.577)	(0.410)	(0.627)	(3.047)
Mining Fraction GSP	-0.996*	0.422	0.574	8.393
	(0.533)	(0.377)	(0.715)	(6.457)
Population	-0.146*	-0.0137	0.160*	-0.548
	(0.0778)	(0.0768)	(0.0815)	(0.607)
Urban Fraction of Pop	5.901	-2.108	-3.793	-19.55
	(3.451)	(1.933)	(3.970)	(22.14)
Average Family Size	0.121*	0.0270	-0.148*	-0.973**
	(0.0652)	(0.0397)	(0.0800)	(0.416)
Fraction of Adults with BA	0.0644	0.0273	-0.0917**	-0.328
	(0.0412)	(0.0260)	(0.0370)	(0.480)
Fraction of Adults Graduating HS	-0.0594**	0.0268*	0.0325**	-0.449**
	(0.0231)	(0.0137)	(0.0148)	(0.212)
Vehicle Miles per Capita	0.00245	0.00219	-0.00464	0.435
	(0.00642)	(0.00523)	(0.00626)	(0.349)
Percent Budget Surplus	0.0458	0.0169	-0.0627	-0.0331
	(0.0430)	(0.0237)	(0.0499)	(0.504)
Senate LCV Score	-0.0000403	-0.0000276	0.0000679	-0.00271
	(0.000366)	(0.000127)	(0.000376)	(0.00292)
House LCV Score	0.000148	-0.000259	0.000111	0.00311
	(0.000337)	(0.000235)	(0.000289)	(0.00280)
Democrat Governor	-0.00216	-0.00846	0.0106	0.0839
	(0.00572)	(0.0108)	(0.00944)	(0.223)
Fraction Democrat State Senate	0.0978	-0.0818	-0.0160	-0.225
	(0.0914)	(0.0867)	(0.0603)	(0.579)
Fraction Democrat State House	-0.0149	-0.0855	0.100	-0.433
	(0.129)	(0.0725)	(0.131)	(1.196)
Observations	831	831	831	831
R-Squared	0.0525	0.0712	0.0782	0.110

Standard errors clustered by year are in parentheses.

*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

All dependent and independent variables are first-differenced. All specifications include year fixed effects.

Table 5: Point of Tax Collection and Incidence

	(1)	(2)	(3)	(4)
Real diesel tax	-0.086	-0.025	-0.120	-0.098
	(0.021)***	(0.022)	(0.055)**	(0.071)
Collect tax from terminal		2.875	0.445	0.824
		(0.268)***	(0.604)	(0.658)
Collect tax from distributor		1.378	0.192	-0.308
		(0.188)***	(0.626)	(0.656)
Real tax * Collect from terminal			0.209	0.162
			(0.052)***	(0.057)***
Real tax * Collect from distributor			0.100	0.139
			(0.056)*	(0.057)**
Real neighbor's tax	0.080	0.275	0.276	0.249
	(0.046)*	(0.051)***	(0.050)***	(0.051)***
Degree days	0.087	0.094	0.095	0.078
	(0.066)	(0.063)	(0.062)	(0.061)
Degree days * HH Fuel oil frac	0.468	0.460	0.460	0.459
	(0.085)***	(0.080)***	(0.079)***	(0.078)***
Unemp. Rate	-0.064	-0.128	-0.135	-0.132
	(0.061)	(0.062)**	(0.063)**	(0.062)**
Real diesel tax * year dummies				X
Observations	5435	5435	5435	5435
R-squared	0.98	0.98	0.98	0.98

Standard errors clustered by year*month are in parentheses.

*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

The dependent variable is the real tax exclusive retail price of number 2 diesel.

Each specification includes state fixed effects and year*month effects.

Table 6: Point of Tax Collection and Wholesale Prices

	Dependent variable:			
	Resale price		Retail price	
	(1)	(2)	(3)	(4)
Real diesel tax	-0.002	-0.024	-0.120	-0.098
	(0.017)	(0.038)	(0.055)**	(0.092)
Collect tax from terminal	1.959	-0.803	0.445	0.987
	(0.259)***	(0.404)**	(0.604)	(1.785)
Collect tax from distributor	0.686	0.575	0.192	-0.296
	(0.163)***	(0.408)	(0.626)	(1.323)
Real Tax * Collect from supplier		0.240	0.209	0.028
		(0.037)***	(0.052)***	(0.164)
Real tax * Collect from distributor		0.001	0.100	0.099
		(0.039)	(0.056)*	(0.153)
Real Price for Resale				0.535
				(0.057)***
Lag Real Price for Resale				0.240
				(0.033)***
R2	0.99	0.99	0.98	0.99
N	5,427	5,427	5,435	5,349

Standard errors clustered by year-month are in parentheses.

*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

The price for resale is a measure of the wholesale price, as it is the price charged for diesel that will be resold to another party. The other included controls correspond to those in the specification shown in column (4) of Table 5.

Table 7: Point of Tax Collection and Incidence

	States shifting point of taxation from:			
	Distributor to supplier		Retailer to distributor	
	(1)	(2)	(3)	(4)
Real Diesel Tax	-0.149	-0.150	-0.319	-0.315
	(0.100)	(0.140)	(0.089)***	(0.085)***
Real tax * Post reform	0.227	0.229	0.677	0.677
	(0.090)**	(0.151)	(0.087)***	(0.088)***
Post reform	-1.555	-1.583	-5.363	-5.400
	(0.986)	(1.765)	(0.943)***	(1.003)***
Real tax*months relative to change		-0.00002		0.0001
		(0.001)		(0.001)
Months relative to regime change		0.070		0.161
		(0.010)***		(0.012)***
R2	0.98	0.98	0.99	0.99
N	1,004	1,004	751	751

Standard errors are in parentheses.

*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

The dependent variable is the real tax exclusive retail price of number 2 diesel.

The other covariates are identical to those included in the specification shown in Column (3) of Table 4.

Months relative to regime change is a variable equal to the number of months prior to or after the stated regime change. Specifications (1) and (2) include all observations from states that experienced a shift in the point of collection from the wholesale distributor level to the prime supplier level. Specifications (3) and (4) likewise include all observations from states that experienced a shift in the point of collection from the retail level to the wholesale distributor level.

Table 8: Point of Tax Collection and Taxed Gallons

Dependent variable: Change in log gallons of taxed diesel

	(1)	(2)	(3)
Retailer to Distributor	0.073	0.081	0.080
	(0.044)	(0.050)	(0.051)
Retailer to Supplier	0.078	0.072	0.069
	(0.039)**	(0.035)**	(0.030)**
Distributor to Supplier	0.015	0.009	0.005
	(0.033)	(0.033)	(0.030)
Log price		-0.384	-0.459
		(0.161)**	(0.170)***
Log (1 + tax rate)		-0.456	-0.625
		(0.269)*	(0.306)**
Log GSP		0.430	0.531
		(0.144)***	(0.154)***
Unem. Rate		-0.010	-0.013
		(0.005)*	(0.005)**
Log Minimum neighbor tax		-0.103	-0.112
		(0.056)*	(0.056)*
Log degree days		-0.029	-0.023
		(0.038)	(0.031)
Log degree days X HH Oil Use		0.014	0.014
		(0.078)	(0.084)
Lagged change in collections			-0.351
			(0.035)***
R2	0.10	0.14	0.25
N	960	940	940

Standard errors clustered by state are in parentheses.

*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

The dependent variable is the change in the log of the number of gallons of special fuel on which state taxes were collected. The log tax rate is defined as $ln(1 + t/p)$. The other independent variables are all first-differenced. Each specification includes year effects. If a regime change occurred mid-year, the regime change dummy is apportioned into the year of the reform and the year after the reform. For instance, shifting to taxing the supplier from the retailer in July of 2005 would cause the variable "Retailer to supplier" to take on a value of 0.5 in 2005 and 0.5 in 2006.