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7365
2018

November 2018

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
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Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
www.cesifo-group.org/wp

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CESifo *Working Paper No. 7365*
Category 1: Public Finance

Will Destination-Based Taxes Be Fully Exploited when Available? An Application to the U.S. Commodity Tax System

Abstract

We develop a tax competition model that allows for the setting of both an origin-based and a destination-based commodity tax rate in the presence of avoidance and evasion. In the presence of evasion, jurisdictions will give cross-border shoppers tax preferential treatment, thus not fully exploiting the potential of destination-based taxation. Moreover, the divergence between origin-based and destination-based taxes is stronger when the incentives for consumers' tax-arbitrage opportunities increase. The United States is one example of many such systems. While sales taxes are due at the point of sale, use taxes are due on goods purchased out-of-state. We document that when able to set both rates, a majority of jurisdictions levy destination-based use taxes at a lower rate than origin-based sales taxes. In response to changes in state-level policies that increase tax avoidance opportunities, the results of the empirical model broadly confirm our theory.

JEL-Codes: C720, H210, H250, H260, H770, P160, R510.

Keywords: tax evasion, tax avoidance, destination taxation, origin taxation, tax competition, use tax, sales tax.

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November 2018
Previously circulated under the title "Commodity taxation with honesty, avoidance and evasion: Evidence from the United States". The foundations for this project were laid while David Agrawal was a guest researcher at the CES in Munich. He thanks CES and Ludwig-Maximilians-Universität München for their hospitality and support. We thank Sanjukta Das, Andrew Jonelis and Cole Rakow for excellent research assistance. We thank the editor, Julie Berry Cullen, two anonymous referees, John Anderson, Jan Brueckner, Traviss Cassidy, William Fox, William Hoyt, Marko Köthenbürger, David Merriman, Odd Erik Nygård, Yaniv Reingewertz, David Wildasin and John Wilson and participants at the Royal Economic Society Annual Conference, the 9th Norwegian-German Seminar on Public Economics, the International Institute of Public Finance Congress, the ASSA Meetings AEA Session, the Midwest Economic Association Meetings, the National Tax Association Conference, and the MaTax Conference at Zentrum für Europäische Wirtschaftsforschung (ZEW). Any remaining errors are our own.

> "There is in principle no reason why destination and origin taxes should not both be levied (and in practice elements of both can almost always be found)."
> – Keen and Lahiri (1998), p. 326.

The theoretical literature on commodity tax competition has extensively analyzed the implications of taxation according to the origin principle – taxation based on where the purchase is made. Given disparities in commodity tax rates across countries and regions, consumers have incentives to engage in tax avoidance via cross-border shopping. The mobility of consumers provides governments with an incentive to attract cross-border shoppers by lowering their commodity tax rate, resulting in inefficiently low commodity tax rates. Instead, if commodities are taxed according to the destination principle – taxes are based on where the consumer resides – a consumer will pay the same tax irrespective of where the purchase has been made. Eventually, destination-based taxation would eliminate the incentives of governments to compete for mobile shoppers and reduce tax competition.[1] This leads to the presumption that destination-based taxation is more favorable.[2] However, and in contrast to models of personal or corporate taxation, these models of commodity tax competition usually abstract from tax evasion (not paying taxes legally due to the home jurisdiction on cross-border transactions).

In the United States, taxation of commodities falls under both sales and use taxes. Sales taxes are due at the point of sale (origin-based), while use taxes are due to the jurisdiction of residence on any transaction purchased in a lower-sales tax jurisdiction than the home jurisdiction (destination-based). Both sales and use taxes are levied by towns, counties and states. The conventional wisdom is that the use tax rate is levied at the same rate as the sales tax, which, if enforced, would imply destination-based taxation at the "full" (sales tax) rate. However, we document that approximately 15% of localities do not fully exploit destination-based taxes and instead set their use tax at a lower rate than their sales tax. These differences appear either in states where localities have the flexibility to set both local sales and local use taxes, or in states which ban localities from levying local use taxes. In states where localities have the authority to set different sales and use tax rates, 60% of towns set lower use tax rates than sales tax rates. Why do some municipalities not fully exploit the potential of their destination-based use tax but instead give cross-border shoppers preferential tax treatment?[3]

[1] See also Diamond and Mirrlees (1971) and Keen and Wildasin (2004) for arguments in favor of the destination principle and Lockwood (2001) for a more general analysis.

[2] When the product market is imperfectly competitive (Keen and Lahiri 1998; Keen, Lahiri and Raimondos-Möller 2002) and/or taxes are set non-cooperatively (Lockwood 1993), the origin principle may Pareto-dominate the destination principle.

[3] The question of our analysis can be related to almost any other tax system. For example, some countries exempt a certain fraction of dividends remitted by foreign subsidiaries from domestic taxation, but require a small part to be subject to domestic taxation (see, e.g., Dharmapala, Foley and Forbes

In answering this question, tax evasion resulting from the failure to file destination-based use taxes will play a critical role, which despite its ubiquity, is an element not captured in models of commodity tax competition. The reason for ubiquitous use tax evasion lies in the specific features of the U.S. commodity tax system, which, in contrast to the sales tax, does not require sellers to remit the use tax on cross-state transactions. Despite the legal requirement of consumers to remit use taxes on cross-border transactions, consumers often report no transactions to the tax authority.[4] This issue is important given that one solution common for individual income taxation – third party reporting (Kopczuk and Slemrod 2006; Kuchumova 2017) – is not readily available for cross-border transactions. Despite high levels of evasion, enforcement is high on items that require registration such as cars. Thus, the amount of use tax revenue usually lies in the range of 10 to 20% of sales tax revenue. In addition, for small local governments lacking any brick-and-mortar retailers, the use tax may bring in more revenue than the sales tax.

The U.S. commodity tax system, with its origin-based sales tax and its destination-based use tax, offers an interesting opportunity to understand why jurisdictions may not fully exploit the potential of their destination-based commodity taxes. So far, the public finance literature concerning commodity taxation has focused on consumers' choices to *avoid* sales taxes. Although the literature has recently addressed commodity tax avoidance by firms, consumer *evasion* responses remain understudied.[5] We therefore develop a theoretical model in the spirit of Kanbur and Keen (1993) and Nielsen (2001), which distinguishes between tax avoidance and tax evasion while also allowing for compliant taxpayers. Jurisdictions set both sales and use tax rates. In our model, as is common to this literature, cross-border shopping is unidirectional, that is, from the high-tax to the low-tax jurisdiction. *Tax avoidance* occurs when an individual buys goods in a nearby low-tax jurisdiction, thus avoiding the origin-based sales tax. *Tax evasion* occurs when that same individual fails to report this cross-border transaction to the tax authority thereby evading the destination-based use tax. A taxpayer is *honest* or *compliant* if she reports cross-border transactions truthfully.

We first show that the commodity tax system will feature destination-based taxation at the full rate, that is local use taxes will be set at the same rate as local sales taxes, if the probability of detecting tax evasion is sufficiently high. If the probability

(2011); Hasegawa and Kiyota (2017) and Bucovetsky (2016)).

[4]Even in the most compliant state, only 10 percent of tax returns declared a non-zero tax liability. In other states, less than 1 percent of tax returns report non-zero cross-border or online purchases.

[5]The one paper analyzing use tax evasion is Trandel (1992), which shows theoretically that use tax evasion can be welfare enhancing because it encourages firms near the state border to price goods closer to marginal cost. Other studies have analyzed evasion of excise taxes in the diesel setting, see Marion and Muehlegger (2008), Agostini and Martínez A. (2014), and Kopczuk et al. (2016). Firms may also evade taxes by failing to report the correct amount of taxable sales (Pomeranz 2015; Naritomi 2015; de Paula and Scheinkman 2010).

of detection is high, evasion will not occur in equilibrium. Setting the use tax equal to the sales tax will nullify the incentives to avoid the sales tax by cross-border shopping. Instead, if the probability of detection is sufficiently low, it is optimal for municipalities to tax discriminate in favor of residents cross-border shopping in the neighboring municipality by reducing the use tax rate below the sales tax rate which implies that the destination-based use tax will not be fully exploited. The reason is that, in the presence of tax-driven cross-border shopping, reducing the use tax rate below the sales tax rate ultimately reduces tax evasion (see Berger et al., 2016 for a similar argument, in a different context). Thus, the use tax is not exploited to achieve destination-based taxation at the full rate and fight tax avoidance, but rather to reduce tax evasion.

Second, because no reliable data on municipality-specific use tax audit probabilities exist and to generate testable predictions, we theoretically analyze how an increase in the state sales tax differential that encourages cross-border shopping affects the divergence of the local sales and use tax rate. We conduct this analysis for municipalities of states that have discretionary power in setting local use taxes but also for municipalities of states that completely ban positive local use tax rates. We find that, for towns on the high-tax side of a state border, if municipalities are allowed to set both tax rates, the difference between the local sales and use tax rate increases following an increase in the state sales tax rate differential (and thus arbitrage opportunities), but the difference in the two local rates decreases for municipalities with a local use tax ban. In low-tax states, municipalities only adjust the sales tax rate in response.

Third, because our cross-border shopping model only allows us to derive testable predictions for border-municipalities, we extend our model to analyze the implications of online or mail-order catalog purchases. The difference from the cross-border shopping model is that all municipalities in our model become high-tax municipalities relative to the Internet because online vendors without nexus are not obliged to remit sales taxes. Consumers are responsible for remitting destination-based use taxes on these remote purchases. We find that in the presence of online shopping, the taxing incentives for municipalities that are located sufficiently far away from the state border, are qualitatively the same compared to the high-tax municipality in the cross-border shopping model. That is, if municipalities at the interior of a state are allowed to set both sales and use tax rates, the difference between the local sales and use tax rate increases following an increase in the incentives to shop online (an increase in the own-state sales tax rate) but the difference decreases for municipalities with a local use tax ban.

We then empirically test why a municipality may levy its use tax rate at a different rate than the sales tax rate and verify whether this is consistent with the theoretical predictions of the model. To do this, we use a novel panel data set on all local use tax rates in the United States and merge it with comprehensive panel data on all local sales tax rates. We assemble data on the local use tax rate for every town, county and special district in the United States at the monthly frequency from September 2003 to December 2011. This data assembly and cleaning process results in the most comprehensive database concerning the state and local commodity tax system. Exploiting exogenous shocks to cross-border shopping opportunities resulting from state-level sales tax rate changes in the municipality's nearest neighboring state, the empirical model yields results generally consistent with the theoretical: in high-tax border towns where localities set both rates, sales and use taxes diverge when state sales tax rate differentials at borders increase, but the opposite pattern arises if use taxes are banned. In response to the own-state tax rate, we find similar results for towns sufficiently far from the state border where online shopping is likely to be an important means of tax avoidance. This provides evidence that jurisdictions use destination-based taxes as a way to fight tax evasion, which implies a deviation from destination-taxation at the full sales tax rate.

Tax evasion is, of course, not simply a U.S. phenomenon and our results are also applicable in the context of cross-national transactions subject to either Value Added Taxes (VAT) or excise taxes (Keen 2013). Indeed, cross-border shopping in response to commodity tax differences is a concern for Europe and developing countries. Consider as an example, a Swiss resident who engages in cross-border shopping in Germany. Generally, the Swiss resident can ask for a VAT refund slip to get a full rebate on his VAT paid after approval at German customs. If the value of the purchase is less than the *de minimis* exemption, then no tax liability is due upon the importation of the purchase. If the Swiss resident exceeds the *de minimis* threshold, he still gets the full rebate approved at German customs but is legally required to declare his purchase at Swiss customs and pay the Swiss taxes. However, by not declaring his purchase he can evade the additional tax payments if Swiss customs fails to detect the individual. This policy instrument – the availability of an exemption – is equivalent to setting the item's use tax rate in our model to zero, which is less than the Swiss tax rate. The justification of the *de minimis* rule is consistent with the intuition of our model: additional taxes upon importation should be lower if the probability of detection is sufficiently low because in the absence of a *de minimis* rule, identifying small purchases is very costly for the tax authority.[6]

Current practice suggests that audit probabilities of consumers concerning commodity taxes are extremely low. If increasing the detection probability of consumer tax evasion is very costly in the short run, our results imply that a second-best policy is to not fully exploit the potential of destination-based taxes and instead set preferential tax rates on purchases made outside of the place of residence ("abroad") relative to purchases

[6] *De minimis* rules are widely used. One example is exemption thresholds on customs declaration forms at airports.

made at home. Abstracting away from administrative costs, we conclude that restrictions in the Streamline Sales and Use Tax Agreement[7] which imply full utilization of destination-based taxation likely lead to sub-optimal tax policies and thus, lower welfare.

Our model also has parallels to other taxes. One such parallel is the incentive of individuals to shift income between corporate and individual income tax bases. Usually, corporate income tax rates are lower than individual income taxes. By shifting income to the corporate tax base, for example, via changing compensation for executives, individuals can *avoid* the higher personal income tax rate, which reduces their total tax liability without changing the total tax base (see Gordon and Slemrod 2000; Elschner 2013). However, individuals may also *evade* taxes by underreporting this compensation at the individual level thereby reducing the overall tax base. One standard argument in the previous literature for why corporate income tax rates are lower than personal income tax rates is that capital is more elastic than labor. In the spirit of our model, another reason for lower corporate tax rates can be that detecting personal income tax evasion is costly – especially when third-party reporting is not available, as in this example – and can result in low detection probabilities by the tax authority. Although reducing the corporate income tax rate increases avoidance by shifting income from the personal income to the corporate income tax base, it will also reduce personal income tax evasion if the same condition as in Allingham and Sandmo (1972) applies, i.e. decreasing absolute risk aversion. Thus, if the change in evasion dominates the change in avoidance, then a lower corporate income tax rate is revenue improving as in our model.

1 Institutional details and data

1.1 Use tax regulations

In the United States, commodity taxes (sales and use taxes) are decentralized to the states, which often allow for county and town taxes. The use tax is due when "(1) out-of-state purchases are taxable in the destination state, (2) the items are brought into the destination state for use or storage and (3) the sales tax was not paid at point of purchase or was paid at a lower rate at the point of purchase in another state."[8] In cases where the sales tax rate was paid at a lower rate, individuals are usually responsible to remit only the difference between the sales tax paid and the use tax rate in the jurisdiction of residence, i.e. they receive a tax credit for sales taxes paid to other jurisdictions to avoid double taxation. The mechanisms for collecting state and local use taxes differ by states, but many states collect the use tax through the individual income tax system, which facilitates

[7] Among many other restrictions on the tax system, this agreement requires: "If the local jurisdiction levies both a sales tax and use tax, the local rates must be identical."

[8] See Agrawal and Fox (2017).

audits through standard income tax audits conducted by the *state* government.[9] Vehicle registration requirements are another way of enforcing use taxes on a particular purchase. Absent registration requirements, the obligation to remit the use tax falls on the consumer and use taxes are often evaded on cross-border purchases (Manzi 2012).

Despite large avoidance and evasion opportunities, sales and use taxes are an important part of state and local government revenue. For example, in 2013, states and localities raised 327 billion dollars from general sales and use taxes. By comparison, state and local governments raised 338 billion from the individual income tax. At the local level, commodity tax revenue is the second largest own-source of revenue making up 13% of general revenue in states allowing for the local taxes.

In order to gain an appreciation of how important use tax revenues are in these statistics, we checked sales and use tax collections data. Only some states report revenue from sales taxes and use taxes separately. Use tax revenues usually amount to 10%-20% of sales tax revenues.[10] To our knowledge, Missouri is the only state that releases sales and use tax data at the local level. Because the average town is small, average municipal use tax revenue is about 10% of total sales and use tax revenue. Yet, the top decile of municipalities, based on the fraction of use tax relative to total sales and use tax revenues, derives just over 50% of revenue from use taxes. These are mainly towns that lack brick-and-mortar retailers and that obtain a substantial fraction of their commodity tax revenue from reported use tax purchases, i.e., cars. Thus, for some (small) towns, the use tax is a *more* important instrument from a revenue perspective than the sales tax.

1.2 Survey of the states

States differ in their sales and use tax regulations and the autonomy given to localities when setting these tax rates. We survey all states about their local sales and use tax regulations. To conduct the survey, we contact (either by phone or email) each of the fifty state departments of revenues and ask the following questions.

1. Are local jurisdictions (counties, municipalities) allowed to levy local use taxes?
2. If local jurisdictions are allowed to levy use taxes, can they differ from local sales tax rates and if so, why?

Table A.1 summarizes the results. We identify eleven states where *local* use taxes differ from sales taxes. In all these states, the *state* sales tax rate and use tax rate are equal. Thus, all differences in origin- and destination-based taxes comes from differences at the local level. Five of the states (Iowa, Illinois, Mississippi, New Mexico, and Vermont) pro-

[9] If individuals file use taxes on the individual income tax return, some states allow filing based on a presumptive formula. Then, the use tax becomes an income tax surcharge rather than a commodity tax.

[10] See appendix A.1 for state-specific revenue totals.

hibit localities from setting local use tax rates. We refer to these states as "ban" states.[11] The other states (Alabama, Alaska, Arizona, Colorado, Oklahoma, and Missouri) allow municipalities to set sales and use taxes at different rates. The rationale given for why the rates differ include "the locality sets the rate", "the state constitution allows them to differ", and "sales tax legislations were enacted before use tax legislation."

1.3 Tax rate data

We assemble a database, described in more detail in Appendix A.2, of all local use taxes in the United States that is similar to local sales tax data assembled in Agrawal (2014). The data have complete geographic coverage of states, towns, counties, and special taxing districts in the United States including Alaska, Hawaii, and the District of Columbia. This includes just under 22,000 towns and approximately 3100 counties in the United States. We observe the tax rates at disaggregated levels (state, county, city/town, and district) and we calculate a total sales and use tax rate in each town. The data cover the period from September 2003 to December 2011. To our knowledge, no other study has ever assembled even a cross-section of local option use tax rates for a single state. To these data we merge control variables from the American Community Survey (ACS).

1.4 Summary statistics

Table 1 shows the average sales and use tax rates at various points in time. The upper panel uses towns in all states that allow for local sales taxes (states requiring sales and use taxes to be equal, states banning local use taxes, and states allowing for sales and use taxes to differ), while the lower panel focuses on states allowing for flexible setting of both local sales and use taxes. For simplicity, we omit statistics for towns in states with use tax bans. The average local sales tax rate in the first panel is approximately 1.53 percentage point. But, the average local use tax rate is 1.19 percentage point. Over 15% of towns have use taxes less than sales taxes but no towns have a use tax rate higher than the sales tax rate. In the second panel, the average local sales tax rate is 2.95 percentage points and the local use tax rate is 1.50 percentage points. In this set, local sales taxes are higher than the national average in the upper panel suggesting these states may be different from other states. We return to this point in our empirical analysis.

Table 2 shows statistics for states where sales and use taxes differ. We present the fraction of towns in our sample that set different local sales and use taxes. In ban states where most towns set non-zero sales tax rates, such as New Mexico, nearly one-hundred percent of the towns have local use tax rates that are lower than sales taxes. In ban states, such as Mississippi and Vermont, where most towns do not set local sales

[11] The state of Illinois bans local use taxes but allows municipalities to collect tax revenue on extra-municipal, interstate purchases of registered goods such as cars. The revenue received by the municipality comes from the state use tax. During our data sample, Idaho constrained counties to set county sales tax rates equal to county use tax rates, but banned towns from levying local use taxes. Accordingly, we exclude Idaho from our sample. Since the end of our data, Idaho has abolished county taxes.

tax rates, this percentage can be very small. In states with the flexibility to set both, over 60% of towns set different rates, but there is substantial heterogeneity across states. Generally, the difference between local sales and use taxes has been widening over time.

2 A model of sales and use taxes

2.1 Basic framework

We construct a model of commodity tax competition with sales tax avoidance (Kanbur and Keen 1993) and extend it to allow for the possibility of use tax evasion.[12] The model has two municipalities located in the interval of [-1; 1] each in a different state. To analyze asymmetries, we suppose that one municipality is larger than the other. Inspired by Nielsen (2001), the larger municipality ranges from -1 to b, with $b > 0$, while the smaller municipality range from b to 1. Population density is unity, resulting in population sizes of the large and the small municipality of $1 + b$ and $1 - b$ respectively. As an additional source of heterogeneity designed to capture tax avoidance incentives due to factors outside the control of the municipality, we assume that the border between the two municipalities is a state border. Each state levies a state sales tax rate T_i and municipalities levy an additional local sales tax rate t_i, $i = \{h, l\}$, on the purchase of consumption goods within their borders. We assume the large town is in the high-tax state, i.e. $T_h > T_l$.[13]

Differences in sales tax rates may induce some individuals to shop across the border in order to *avoid* the sales tax rate they have to pay in their home jurisdiction. To thwart this behavior, the high-tax state and its municipality also impose a state and a local use tax, Γ_h and τ_h, respectively, which has to be paid by the individuals when declaring a cross-border purchase was made. Already paid sales taxes can be credited against the due use taxes if use taxes in the resident jurisdiction are higher than sales taxes of the jurisdiction of purchase. However, individuals may also decide to not declare the purchase and thereby *evade* the use tax, which is illegal. Doing so causes idiosyncratic costs of evasion $m_i \in [0; \bar{m}]$ because individuals have internalized norms of tax compliance to varying degrees (Dharmapala 2016; Gordon 1989). Lower values of m_i indicate lower costs of engaging in tax evasion and in turn a lower incentive to comply with the tax law. Following Berger et al. (2016), individuals draw their idiosyncratic cost parameter

[12] For other variants, see Mintz and Tulkens (1986), de Crombrugghe and Tulkens (1990), Trandel (1994), and Haufler (1998). Janeba and Osterloh (2013) and Agrawal (2015) address concerns important for local tax competition. See Janeba and Peters (1999) for a model of tax competition with evasion and Wilson (1999) or Keen and Konrad (2013) for a survey of tax competition models.

[13] We assume in equilibrium that $t_h \geq t_l$, which will be true if b is sufficiently large. We do this to avoid irrelevant cases where the use tax rate is smaller than the sales tax rate of the neighboring jurisdiction and hence ineffective. Under this assumption, the use tax is irrelevant for the low-tax jurisdiction and need not be modeled. In a two jurisdiction setting, given tax credits against sales taxes already paid, a jurisdiction setting its use tax to zero is equivalent to setting the use tax at the neighbor's sales tax rate. Furthermore, $T_h > T_l$ is exogenous to our model and could be a result of differences in state-sizes, but could also be a result of other factors such as differences in public good preferences (Haufler 1996).

from a cumulative distribution function $G(m_i)$, where $G(0) = 0$ and $G(\bar{m}) = 1$, with a probability density function of $g(m_i)$. Then, in the spirit of Allingham and Sandmo (1972), if an individual does not declare the purchase, she gets caught by the domestic tax authority with an exogenously given probability of p, determined by the state, and has to pay an additional exogenous fine f to the state.[14] The exogeneity of p and f is plausible because these are usually state-level policies.

Firms are in a perfectly competitive environment and hence set their prices to marginal costs which we normalize to one. Individuals' maximum willingness to pay, denoted by V, is uniform across jurisdictions and all individuals wish to purchase one unit of the good. We summarize the model's notation in Table 3.

2.2 Optimal behavior of individuals

Individuals can decide whether to purchase the good in their home municipality h or in the neighboring municipality l ("abroad"). Given that firms may locate anywhere along the line segment, if the consumer purchases the good at home, she has to pay the combined sales tax rate $T_h + t_h$ but does not incur any transport costs. Total surplus of purchasing at home will be $V - 1 - T_h - t_h$. As an alternative, some individuals may cross-border shop.[15] If individuals residing in the high-tax state are compliant, they have to pay the combined local sales tax rate of the neighboring jurisdiction $T_l + t_l$ upon sale and the combined use tax rate $\Gamma_h + \tau_h$ upon declaration of the imported good. Already paid sales taxes can be credited against the use taxes such that the additional use tax payments in the home jurisdiction amount to $\Gamma_h + \tau_h - T_l - t_l$ if they decide to purchase the good abroad. Thus, total tax payments amount to $\Gamma_h + \tau_h$. Additionally, when avoiding the home jurisdiction's sales tax rate by cross-border shopping, they incur the cost of traveling to the border (and back) in the amount of δ per unit of travel S_i. Conditional on not evading the use tax, compliant individuals from the high-tax state will purchase the good abroad if the surplus of doing so is greater than buying the good at home

$$\delta S_i \leq t_h - \tau_h, \tag{1}$$

where we assume, as is empirically always the case, that the state sales and use tax rates are equal, i.e. $\Gamma_h = T_h$ (we derive all trade-offs in Appendix A.3). Define the distance to

[14] An alternative interpretation is that p represents the exogenous fraction of one dollar of income spent on goods subject to registration, e.g., cars, and f is the fee incurred from registration, whereas the fraction $1 - p$ is spent on goods not subject to registration. Under this interpretation, use tax evasion is zero for cars given the need to register the vehicle and 100% for all small purchases, with a zero chance of detection for the latter but where some people may not evade because of m_i. In that case, our framework nests a two good model. We do not formally model the division of the tax base (Wilson 1989).

[15] In our model, cross-border shopping is unidirectional, because it is solely driven by tax considerations. Hence, whenever we refer to cross-border shopping, we mean outward cross-border shopping from the perspective of the high-tax municipality h, i.e. individuals residing in h shopping in l.

the border of the individual that is indifferent between purchasing the good at home or abroad as $S^C \equiv (t_h - \tau_h)/\delta$. Only individuals with distance of at most S^C units to the border will opt to purchase abroad if there is no evasion.

However, individuals can decide whether to shop abroad without declaring their purchases to the tax authority. With probability $1-p$ they will not be caught by the tax authority and only have to pay the combined local sales tax $T_l + t_l$. With probability p, however, they get caught and have to pay jurisdiction l's combined local sales tax $T_l + t_l$ and jurisdiction h's combined use tax that exceeds already paid sales taxes $\Gamma_h + \tau_h - T_l - t_l$ plus an additional fine f to the state. Irrespective of being caught or not, an individual incurs costs m_i due to the act of evasion. When use tax evasion is possible, an individual from jurisdiction h will shop abroad and evade the use tax if

$$m_i \leq t_h - \tau_h - \delta S_i + (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right) - pf \quad \equiv \quad m_i^E. \tag{2}$$

Define the distance to the border of the individual who is indifferent between purchasing the good at home or purchasing abroad and evading the use tax as S^E if her cost m_i is exactly zero. Thus, $S^E = [t_h - \tau_h + (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right) - pf]/\delta$. Only individuals with a distance of at most S^E units to the border may opt for a purchase abroad if use tax evasion is feasible. The trade-off contains two kinds of idiosyncratic costs: the spatial cost of travel and the cost of evasion. This means that although an individual is relatively close to [far away from] the border, i.e. S_i is relatively small [large], she could prefer to purchase the good at home [abroad] because her evasion cost m_i is too high [sufficiently low]. Individuals have a specific threshold m_i^E below which they will purchase abroad.

Whether an individual who decided to purchase the good abroad will evade the use tax or declare the purchase depends on the expected fine. She will *evade* the use tax if her net gain from evading is positive:

$$m_i \leq (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right) - pf \ \equiv m^A. \tag{3}$$

Inequality (3) states that the set of cross-border shoppers as defined in (1) can be divided into two subsets: the only sales tax *avoiders* and the also use tax *evaders*. These cross-border shopping individuals self-select into one of the two groups depending on their idiosyncratic cost of evasion. Whether the avoiders or the evaders account for the larger group depends on the size of the expected fines. For our main analysis, we will consider the case in which both avoiders and evaders are present and relegate much of the analysis with only compliant individuals to Appendix A.6. The model will be characterized by both types of consumers if the size of the expected fine is sufficiently low:

$$pf \ \leq (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right). \tag{4}$$

Assumption (4) tells us that $m^A > 0$. Hence, some cross-border shoppers will evade the use tax while others will be compliant. Figure 1 summarizes individuals' shopping and evading decisions. Each axis represents the two possible idiosyncratic components characterizing an individual: the distance to the border S_i on the horizontal axis and the cost of evasion m_i on the vertical axis. The space is partitioned into three types of individuals: cross-border shoppers who avoid the sales tax but dutifully pay the use tax, cross-border shoppers who also evade the use tax, and individuals that shop at home.

Specifically, all individuals for which $S_i \leq S^C$ will evade the use tax if $m_i \leq m^A$, but dutifully pay the use tax if $m_i > m^A$. Additionally, some more distantly located individuals, $S_i \in \left(S^C; S^E\right]$, may choose to shop across the border if their evasion cost is sufficiently low, i.e. $m_i \leq m_i^E$. Importantly, for these distant individuals, cross-border shopping is never beneficial if they are compliant, that is if they pay the use tax (cf. eq. (1)).[16] The m_i^E line is downward sloping because the spatial cost of travel and the evasion cost are substitutes. The more distant an individual from the border the lower must be the evasion cost to make cross-border shopping with evasion beneficial. From (2), the slope in the m_i/S_i dimension is $-\delta$.

Finally, we calculate the expected number of compliant and evading cross-border shoppers. The expected number of compliant cross-border shoppers is

$$\pi^C = \int_0^{S^C}\int_{m^A}^{\bar{m}} g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i = S^C\left[1 - G\left(m^A\right)\right], \tag{5}$$

whereas the expected number of evading cross-border shoppers amounts to

$$\pi^E = \int_0^{S^C}\int_0^{m^A} g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i + \int_{S^C}^{S^E}\int_0^{m_i^E} g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i = S^C G\left(m^A\right) + \int_{S^C}^{S^E} G\left(m_i^E\right) \mathrm{d}S_i. \tag{6}$$

2.3 Tax policy

The objective of both local governments is to maximize own-jurisdiction welfare that is defined as the sum of private surplus and tax revenues weighted by $\lambda > 1$, where λ is interpreted as the marginal cost of public funds. Welfare of jurisdictions i is given by

$$W_i = \lambda R_i + CS_i, \quad i = \{h, l\}. \tag{7}$$

We proceed allowing for local sales and use tax rates to be endogenously determined. We assume that all taxes are set in a simultaneous non-cooperative Nash game and that a Nash equilibrium exists. Before we turn to the equilibrium commodity tax

[16] Plugging in S^C into (2) shows the right side of (2) is positive only if $m^A > 0$. Thus, with a sufficiently low cost of evasion, cross-border shopping with use tax evasion is beneficial despite $S_i \geq S^C$.

rates when both avoiders and evaders are present, we want to introduce as a benchmark the equilibrium commodity tax rates when all individuals are compliant. Appendix A.6 shows that, if all consumers are compliant, commodity taxation is destination-based at the “full” (sales tax) rate and removes the harmful effects of mobility in the tax base by effectively “closing” the border. We summarize in:

Proposition 1. *If the probability of detecting use tax evasion is sufficiently high, the commodity tax system features destination-based taxation at the rate of the sales tax and eliminates tax competition for cross-border shoppers.*

Proof. See Appendix A.6.

□

Proposition 1 shows that the combination of the sales tax rate with the use tax rate can eliminate tax competition and restore efficiency. In contrast to the origin-based sales tax, the use tax is based on residency. Because tax avoidance is the only margin the government has to deal with, an alignment of the use tax rate to the sales tax rate completely eliminates tax avoidance without affecting any other margin. Our result is in line with studies showing that the additional use of a residence-based tax on capital besides the familiar source-based tax can restore efficiency (Bucovetsky and Wilson 1991).

Although Proposition 1 is attractive on theoretical and on policy grounds when destination taxation is preferred (Keen and Hellerstein 2010), it has little application in the current U.S. system because the use tax is under-enforced. Proposition 1 does, however, suggest that “full” destination taxation can be achieved with more intense auditing of consumers, which will result in compliant taxpayers.

Moreover, in the Nielsen (2001) model, tax competition occurs because of tax avoidance and an origin-based tax rate. In our model, tax avoidance is not sufficient to generate tax competition, because the availability of a destination-based tax rate (use tax rate) completely eliminates tax competition. Instead, tax competition in our model can only emerge in the presence of tax evasion.

We now turn to the equilibrium commodity tax rates when both avoiders and evaders are present. Total tax revenues in municipalities h and l amount to

$$R_h = t_h \left(1 + b - \pi^C - \pi^E\right) + (\tau_h - t_l)\left(\pi^C + p\pi^E\right), \tag{8a}$$

$$R_l = t_l \left(1 - b + \pi^C + \pi^E\right). \tag{8b}$$

Both municipalities raise sales tax revenues from resident consumers buying the good at home. On top of that, municipality l derives sales tax revenues from cross-border shopping individuals resident in h. Moreover, municipality h generates revenues from collecting the use tax (net of local sales taxes paid) from compliant cross-border shoppers and from caught evaders. The fine f does not appear in town h's revenues because audits are determined by the state and thus the fine f is collected by the state.

In Appendix A.4, we derive total consumer surplus in municipalities h and l

$$CS_h = (1+b)(V-1-T_h-t_h) + \frac{(t_h-\tau_h)^2}{2\delta} + \int_0^{S^C}\int_0^{m^A} G(m_i)\,\mathrm{d}m_i\mathrm{d}S_i + \int_{S^C}^{S^E}\int_0^{m_i^E} G(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \tag{9a}$$

$$CS_l = (1-b)(V-1-T_l-t_l). \tag{9b}$$

Equation (9a) illustrates that residents of municipality h can at least get a surplus of $V-1-T_h-t_h$ if they purchase at home. Compliant cross-border shoppers additionally gain surplus if $\tau_h < t_h$ because they pay the combined use tax rate instead of the combined sales tax rate (second term in (9a)). Moreover, individuals with sufficiently low evasion costs decide to evade the use tax and with probability p they only have to pay the sales tax rate t_l (last two terms in (9a)). Because residents of municipality l do not engage in cross-border shopping, their surplus will always be $V-1-T_l-t_l$.

The first-order conditions of the commodity tax rates are given by

$$\frac{\partial W_h}{\partial t_h} = (\lambda-1)\left(1+b-\pi^C-\pi^E\right) - \lambda\left[(t_h-\tau_h+t_l)\frac{\partial \pi^C}{\partial t_h} + (t_h - p(\tau_h-t_l))\frac{\partial \pi^E}{\partial t_h}\right] = 0, \tag{10a}$$

$$\frac{\partial W_h}{\partial \tau_h} = (\lambda-1)\left(\pi^C+p\pi^E\right) - \lambda\left[(t_h-\tau_h+t_l)\frac{\partial \pi^C}{\partial \tau_h} + (t_h - p(\tau_h-t_l))\frac{\partial \pi^E}{\partial \tau_h}\right] = 0, \tag{10b}$$

$$\frac{\partial W_l}{\partial t_l} = (\lambda-1)(1-b) + \lambda\left[\pi^C+\pi^E+t_l\left(\frac{\partial \pi^C}{\partial t_l}+\frac{\partial \pi^E}{\partial t_l}\right)\right] = 0, \tag{10c}$$

which when simultaneously solved determine the Nash equilibrium of the game. Although closed form solutions cannot be obtained, even if we assumed a specific functional form for the cost of evasion, tax competition remains a relevant channel in our model. For this reason, when conducting comparative statics we will need to allow for the indirect effects resulting from the endogenous adjustment of the neighboring municipality's tax rate.

What do these conditions imply about the equilibrium tax rates? As mentioned earlier, we assume that b is sufficiently large such that we can characterize an equilibrium with $t_h > t_l$. First, we note that the optimal sales tax rate in municipality l is positive but lower than in the case with only compliant cross-border shoppers. The reason is that municipality l has an incentive to lower its sales tax rate because this increases the number of evading as well as non-evading cross-border shoppers from municipality h and hence its tax base. What remains to be clarified is under which conditions municipality h wants to deviate from destination-based taxation at the "full" (sales tax) rate, that is, when the local sales and the use tax rate in h will differ. We state this condition in:

Proposition 2. *If the probability of detecting use tax evasion is sufficiently small, the high-tax municipality deviates from destination-based taxation at the sales tax rate and instead levies preferential taxes in favor of cross-border shoppers by setting the local use tax rate below the local sales tax rate.*

Proof. See Appendix A.7.

□

Figure 2 summarizes the changes following an increase in the local use tax rate when the probability of detection is low. The result mainly originates from how a change in the local use tax rate affects use tax evasion. Generally, an increase in the local use tax rate has an ambiguous effect on use tax evasion. On the one hand, evasion increases because the tax savings from evasion for individuals who certainly cross-border shop increase. This can be seen by inspecting (3), which shows that the benefit of evading the use tax, $(1-p)(\Gamma_h + \tau_h - T_l - t_l)$, is increasing in the local use tax rate, while the cost of evasion, $m_i + pf$, is fixed for a given individual (upward shift of the m^A line in Figure 2). On the other hand, use tax evasion decreases because the tax advantage for individuals, who cross-border shop only if evasion is possible, decreases. This can be seen by inspecting (2), which shows that m_i^E decreases with τ_h (shift of the m_i^E line to the left). However, if p is sufficiently small, the first effect dominates and evasion will increase upon an increase in the local use tax rate (area below the m^A and m_i^E lines increases). Analytically, as $p \to 0$ the use tax becomes irrelevant in (2) and therefore does not affect the trade-off of individuals who would only cross-border shop if they can evade.

As a corollary to this proposition, we can conclude that under the conditions of the proposition, municipal welfare will also be higher when the use tax rate is lower than the sales tax rate compared to when $\tau_h = t_h$. Proposition 2 suggests that if we observe municipalities setting sales and use taxes differently, we can infer something about the probability of detection (broadly defined) in the municipality. Empirically, municipalities with a sales tax different from a use tax are likely to have lower detection rates.

Ideally, at this point, we would like to directly test how measures of use tax enforcement affect local commodity tax rates. Unfortunately, data on time-varying measures of state audits are hard to come by. Further, even if such state-level data were available, the mapping from personal income tax to use tax audits and from statewide to municipality-specific audit rates would be unclear. Thus, we follow a more indirect approach by analyzing how state level tax shocks affect local commodity tax rates.

2.4 The effect of state level tax shocks

We analyze how changes in state tax policies influence locally set sales and use tax rates and then test the implications empirically. As noted in the survey of states, some states allow localities to flexibly set a local use tax rate and some states ban localities from setting a local use tax rate. We analyze each of these sets of states separately. In addition, many states force municipalities to set their local use tax rate equal to the local sales tax rate. Although interesting theoretically, we ignore these states because state-level tax shocks will not affect the difference between local sales and use tax rates, which will be our variable of interest empirically. We analyze how a change in the state sales tax rate differential, which proxies for an increase in cross-border shopping incentives for reasons outside the control of the municipality, affects the difference in local sales and use tax rates, denoted $\Delta_h \equiv t_h - \tau_h$ and $\Delta_l \equiv t_l$. The full analysis is in Appendix A.8.

In states with a ban on local use tax rates, $\tau_h = 0$ and the effect of a change in the state sales tax rate differential $T_h - T_l$ on Δ_i is:

$$\frac{d\Delta_h}{d\left(T_h - T_l\right)} = \frac{dt_h}{d\left(T_h - T_l\right)} < 0, \tag{11a}$$

$$\frac{d\Delta_l}{d\left(T_h - T_l\right)} = \frac{dt_l}{d\left(T_h - T_l\right)} > 0. \tag{11b}$$

Hence, an increase in the state sales tax differential decreases the local sales and use tax differential in high-tax border-municipalities with a ban but increases the differential in low-tax border-municipalities with a ban. Figure 3 summarizes the changes following an increase in the state sales tax rate differential for high-tax border-municipalities with a ban. Intuitively, a higher state sales tax differential will both change the composition of cross-border shoppers and increase cross-border shopping incentives. First, conditional on shopping abroad, the number of evading individuals increases, and hence the number of compliant individuals declines, because the savings from evading use taxes increases (upward shift of the m^A line in Figure 3). Second, because of increased evading incentives, some individuals who initially shopped at home start to purchase abroad (upward shift of the m_i^E line). Because municipality h cannot adjust the use tax to counter evading incentives directly, it reduces the sales tax rate to scale down the overall number of cross-border shoppers in order to indirectly reduce evasion (shift of the S^C line to the left).[17] However, a reduction in the sales tax rate also implies lower sales tax revenue collections from individuals who shop at home. Therefore, the reduction in the local sales tax rate will not fully offset the increase in the state sales tax differential. Finally, and not pictured in the figure, the incentive to reduce t_h is dampened through tax competition because t_l increases and hence partially reduces cross-border shopping incentives. The sales tax increases in town l because the increase in the state sales tax differential increases the inflow of cross-border shopping into the town, which expands the municipality's tax base, resulting in the town raising its sales tax rate. However, this indirect effect of tax

[17]Inspecting (3) shows that t_h does not affect the evasion trade-off of individuals who shopped abroad.

competition is only second order and hence does not overcompensate the direct effect.

For municipalities in states which allow local use tax setting, we need to take into consideration the direct and indirect effects on τ_h. Again, recall that sales and use tax rates only differ if the probability of detection p is sufficiently low. The effect of a change in the state sale tax differential on Δ is given by

$$\frac{d\Delta_h}{d\left(T_h - T_l\right)} = \frac{dt_h}{d\left(T_h - T_l\right)} - \frac{d\tau_h}{d\left(T_h - T_l\right)} > 0, \tag{12a}$$

$$\frac{d\Delta_l}{d\left(T_h - T_l\right)} = \frac{dt_l}{d\left(T_h - T_l\right)} > 0. \tag{12b}$$

An increase in the state sales tax differential will increase Δ in both high-tax and low-tax border-municipalities without a ban. Figure 4 summarizes the changes for municipality h when there is no ban. Intuitively, in high-tax border-municipalities without a ban, an increase in the state sales tax differential has the same effects as in municipalities with a ban, i.e. municipalities have an incentive to lower the sales tax rate to reduce cross-border shopping and, in turn, reduce use tax evasion at the expense of lower sales tax revenues from individuals shopping at home. However, in states without a ban, the high-tax municipality primarily uses the use tax rate to combat the increase in tax evasion which implies a stronger reduction in the local use tax than in the local sales tax. The reason for the stronger reduction in the use tax is that, unlike the sales tax, it is not associated with large revenue losses due to the small use tax base caused by the low probability of detection (shift of the S^C line to the right in Figure 4). However, and similar to before, the changes in the local commodity tax rates will not fully offset the increased incentives induced by a rise in the state sales tax differential (upward shift of the m^A line). Finally, the incentive to reduce tax rates is dampened by tax competition because the increase in cross-border shopping increases municipality l's tax base and thus the sales tax rate t_l. Again, the increase in t_l does not overcompensate the direct effects. Given the use tax is not utilized in the low-tax state, it does not change.[18] We summarize our main result we will test empirically in:

Proposition 3. *In the presence of cross-border shopping, an increase in the state sales tax differential decreases [increases] the local sales and use tax rate differential Δ in high-*

[18]The qualitative difference in municipality l's behavior is not driven by the fact that the municipality does not levy a use tax. Our results hold true also in a more general case containing within state cross-border shopping from municipality l to an even lower-tax municipality within the state, under the assumption individuals can only shop at most one town over. The reason is that a change in T_l will neither affect within-state outward cross-border shopping from municipality l nor use tax evasion because any change in the state sales tax rate is paralleled by an equal change in the state use tax rate. Analytically, we have to substitute Γ_h by Γ_l in equations (2) as well as (3) and use the fact that $\Gamma_l = T_l$. Moreover, changes in T_h neither affect within-state outward cross-border shopping from municipality l nor use tax evasion because T_h does not influence the trade-offs in (2) and (3) recalling that the index h has to be substituted by l.

tax [low-tax] border-municipalities with a use tax ban but increases Δ *in both high-tax and low-tax border-municipalities without a use tax ban.*

Proof. See Appendix A.8.

□

Proposition 3 highlights that border-municipalities will respond to shocks and adjust the sales or use tax rates differently depending on whether they are located in a state that allows local use tax setting or not. This difference in the behavior of border-municipalities allows us to test our predictions by differentiating them into groups. According to Proposition 3, a tax shock should affect the difference in local commodity tax rates differently when we compare high-tax border-municipalities with and without a ban. However, Proposition 3 also illustrates that we cannot use low-tax border-municipalities to make statements about differences in ban and no ban states because the sign of the incentives do not differ between municipalities with and without a ban. The reason is that low-tax border-municipalities do not make use of the local use tax rate because outward cross-border shopping from the perspective of municipality l is not affected. For this reason, we will split our sample into four groups, but studying the role of destination and origin based taxes will be most applicable for high-tax states.

However, we do empirically observe that municipalities in low-tax states levy positive use tax rates and change them over time. One possible reason is that individuals also have the opportunity to purchase goods online or from mail-order catalogs. Although our model is targeted towards cross-border shopping, it can easily be adjusted to accommodate online shopping. To do this, we need to reinterpret some of the model's parameters and we simplify by only allowing for online shopping, which is a reasonable assumption for towns at the interior of the state where interjurisdictional tax differentials are small. Because the spatial dimension will not matter in this model of online shopping, S_i will be interpreted as the idiosyncratic cost of individuals to shop online, where δ measures the importance of individuals' cost (or reversely readiness) to shop online relative to the evasion costs. Finally, we assume that online sales are taxed at a sales tax rate of zero. This assumption can be justified for the period of time we study empirically, where *Quill Corp. v. North Dakota* implies that online vendors without nexus did not need to remit sales taxes. However, individuals are legally required to pay state and local use taxes on online transactions. Hence, both municipality h and municipality l can be treated as high-tax municipalities relative to the Internet. Analytically, this implies that the trade-offs for municipality h also apply to municipality l, the only difference being that we replace T_l by T_o and t_l by t_o and set $T_o = t_o = 0$, where the subscript o stands for online. Thus, although municipalities differ in size ($b > 0$), the first-order conditions for municipality h sufficiently characterize the optimal tax policies for *both* towns h and l.

Under this reinterpretation, the trade-offs we derived in equations (1), (2) and (3) remain valid for towns $i = \{h, l\}$. We abstract from any strategic interactions in commodity taxes and simply analyze an optimal tax model for a single municipality. In this case, low-tax municipalities face the same trade-off as high-tax border-municipalities in the case of cross-border shopping. The only difference to our previous analysis will be that tax revenues given in (8a) will analogously apply to the low-tax municipality due to the revenue leakage induced by online shopping by potentially evading individuals.[19]

Then, we can derive in the presence of online shopping, in states with a ban on local use tax rates, that the effect of a change in T_i on Δ_i is

$$\frac{d\Delta_i}{dT_i} = \frac{dt_i}{dT_i} < 0, \quad i = \{h, l\}, \tag{13}$$

while the effect of a change in T_i on Δ_i in states without a ban is given by

$$\frac{d\Delta_i}{dT_i} = \frac{dt_i}{dT_i} - \frac{d\tau_i}{dT_i} > 0, \quad i = \{h, l\}. \tag{14}$$

That is to say, the signs for interior municipalities facing online shopping are the same as for high-tax border municipalities facing cross-border shopping (given by (11a) and (12a)). Therefore, the intuition for the result is the same as for high-tax border-municipalities. In the absence of a local use tax rate, municipalities have to reduce their sales tax to combat the increase in use tax evasion emerging from increased incentives to shop online. When local use taxes are available, the municipality primary exploits the use tax rate to counter the increase in evasion of online transactions which implies a greater reduction in the local use tax rate compared to the local sales tax rate. We summarize in

Proposition 4. *In the presence of online shopping, an increase in the own-state sales tax rate decreases the local sales and use tax rate differential* Δ *in municipalities with a ban but increases* Δ *in municipalities without a ban, if municipalities are located sufficiently far away from a state border. This result holds for high-tax and low-tax municipalities.*

Proof. See Appendix A.9 □

Proposition 4 highlights that municipalities sufficiently far away from the border will respond to state tax shocks and adjust the sales or use tax rates differently depending on whether they are located in a state that allows local use tax setting or not. The

[19] It is straightforward to verify that Propositions 1 and 2 remain exactly the same because strategic interaction becomes only relevant in our comparative static analyses. However, we also emphasize that this result does not depend on that we abstracted from strategic interactions in local commodity tax rates. As explained in footnote 18, local commodity tax rates will not be affected by changes in state sales tax rates if there is within-state outward cross-border shopping from municipality l. The presence of strategic interaction in local commodity tax rates will only imply they will be set at a lower rate. However, as long as local sales tax rates are positive, Proposition 2 still applies.

difference from Proposition 3 is that we are able to use all municipalities, i.e. high-tax and low-tax, to identify how a own-state tax shock affects the difference in local commodity tax rates. Given Proposition 4 studies towns for which cross-border shopping is insignificant, it is most applicable for towns at the interior of the state. The presence of this form of evasion implies we might find effects from the state tax rate differential for towns far from the border, so much as it picks up own-state tax changes. We can combine the effects of the online shopping and cross-border shopping models in order to make inferences about the effects resulting from both mechanisms in border towns.

We will initially test how changes to state level tax differentials will affect local commodity tax rates in border municipalities. In high-tax municipalities, where the sign depends on whether municipalities have access to a local destination-based use tax rate or are banned from setting this tax, our theoretical model gives clear-cut implications for how high-tax municipalities react to increased avoidance incentives. That is, irrespective of whether tax avoidance occurs because of cross-border shopping or online purchases, an increase in tax avoidance opportunities for individuals residing in a high-tax municipality due to an increase in T_h will result in a decrease [an increase] in Δ_h if the municipality is located in ban [no ban] state. In contrast, our theoretical results for border municipalities on the low-tax side are ambiguous once we take the possibility of online shopping into account. The reason is that, on the one hand, a reduction in T_l will increase Δ_l according to (12b) because the inflow of cross-border shoppers expand the tax base of the low-tax municipality, whereas, on the other hand, it decreases Δ_l according to (14) because the number of online shoppers and hence evaders declines. Eventually, which effect dominates in low-tax border municipalities is an empirical question. Finally, we will present additional results testing the role of online shopping for interior municipalities. This allows us to pool municipalities in high-tax and low-tax states.

3 Evidence on the model

As noted in the introduction, 60% of towns in states with the ability to set local sales and use taxes at different rates, do indeed not fully exploit their destination-based use tax and set it at a lower rate than the sales tax. According to the theoretical model, this suggests the audit probability is low. Because we do not have data on a convincing proxy for the probability of detection in given towns over time, we will provide indirect evidence for the incentives to deviate from destination-based taxation at the "full" (sales tax) rate by using arguably exogenous tax shocks that affect municipalities' tax policies and hence alter $\Delta_{i,t}$, i.e. the local sales tax minus the use tax rate for town i in year t.

As a tax shock to municipalities, we utilize plausibly exogenous changes in the differential in state tax rates at the border. The state tax differential is an important factor that determines cross-border shopping and thus tax avoidance and evasion. State sales tax rates are likely to be exogenous to municipal rates because the vast majority of municipalities are very small and because states likely act as leaders in a tax competition game. This means that states do not likely change their tax rates in response to individual municipal tax changes. Subsequent analysis will address possible violations of this assumption, including common shocks. To be consistent with the comparative statics of our model, we define $\Lambda_{i,t} = \left|T_{i,t} - T^n_{i,t}\right|$ as the absolute value of the state tax differential, where $T_{i,t}$ is the state tax rate in the own-state and $T^n_{i,t}$ is the state tax rate in the nearest neighboring state. The absolute value allows $\Lambda_{i,t}$ to be interpreted as the state-tax rate in the high-tax state minus the state-tax rate in the low-tax state (i.e., in the notation of our theory, $\Lambda_{i,t} = T_h - T_l$). We determine the nearest neighbor following Agrawal (2015) using data on the driving time from the population weighted centroid of municipality i to the nearest state border intersection with a major road crossing. Moreover, in order to partition the sample into the high-tax and low-tax side of the border as suggested by theory, we define $H_{i,t} = 1$ if a town is located in a high-tax state relative to its nearest neighbor (if $T_{i,t} - T^n_{i,t} \geq 0$). Analogously $H_{i,t} = 0$ for towns located in a low-tax state relative to its nearest neighbor (if $T_{i,t} - T^n_{i,t} < 0$).[20]

Before proceeding, we discuss the identifying variation within our sample. When a state changes its tax rate, the state tax differentials at all borders of that state are affected. When a neighboring state tax rate changes, the state tax differential of only one border is affected. In states banning local use taxes, there are 21 unique state borders that realize a total of 21 tax differential changes (some borders have multiple changes while others have none). Of these 21 changes, 8 are tax changes in high-tax states, 10 are in low-tax states and 3 are tax changes that switch the town from the low-tax to the high-tax side. In states which allow flexible local use tax setting, we count 27 unique border pair combinations that realize a total of 24 tax differential changes. Of these, 6 affect towns in high-tax states, and 18 are in low-tax states. Thus, in no ban states, towns never change $H_{i,t}$ while, in ban states, three state borders change this status.

3.1 Event studies

First, we present graphical evidence that suggests municipalities respond to state tax shocks and that pre-trends in municipal taxes do not exist prior to these shocks. The event study also provides evidence of the implicit assumption that municipalities respond contemporaneously – or at least within the same year – to the state tax shock. We present

[20] Linking back to our theory, high-tax status at the state level determines the direction of cross-border shopping. However, in practice a town may be in a high-tax state, but if it is very small compared to a city just over the border, the total tax rate may be lower than the total tax rate in the neighboring low-tax state. On average, regression discontinuity results show that this is not true in equilibrium (Agrawal 2015). For this reason, state tax rates generally characterize cross-border shopping patterns. Any error in this classification will likely bias our results towards zero.

results using an event study specification with variation in treatment timing utilizing the state tax differential changes

$$\Delta_{i,t} = \nu_t + \zeta_i + Treat_i \times \left[\sum_{y=-4}^{-2} \pi_y \mathbf{1}_{\{t-t_i^*=y\}} + \sum_{y=0}^{3} \gamma_y \mathbf{1}_{\{t-t_i^*=y\}} \right] + \mathbf{X}_{i,t}\beta + \varepsilon_{i,t}, \tag{15}$$

where $\Delta_{i,t}$ is defined above, ν_t are time fixed effects, and ζ_i are municipal fixed effects. The vector $\mathbf{X}_{i,t}$ includes a vector $\mathbf{Y}_{i,t}$ of time-varying municipal characteristics comprising demographic characteristics, as listed in Appendix A.2, that also proxy for potential changes in preferences for public spending due to variation in λ, a vector $\mathbf{Z}_{i,t}$ of time-varying state level controls (population, income, demographics, unemployment) and a vector $\mathbf{Z^n}_{i,t}$ of the same controls for the nearest neighboring state for municipality i.

The variable $Treat_i$ indicates whether the municipality experiences a state-level tax shock. Then, $Treat_i$ takes on a value of one for municipalities where $\Lambda_{i,t}$ increases, a value of negative one if $\Lambda_{i,t}$ decreases and zero if the municipality does not experience a change. The reason is that an increase in $\Lambda_{i,t}$ has an opposite signed effect on $\Delta_{i,t}$ compared to a decrease in $\Lambda_{i,t}$. The indicator variables $\mathbf{1}_{\{t-t_i^*=y\}}$ measure time relative to the event change t_i^* (the index y is time since the event). π_y represents the differential evolution of $\Delta_{i,t}$ in the treated town in the years prior to the event while γ_y represent the differential evolution of $\Delta_{i,t}$ for the years after the event. The year prior to the event is omitted from the regression so all coefficients are relative to that year. Towns never experiencing a treatment are in the omitted category. Identification of the effects follows a difference-in-differences with variation in treatment timing where towns not experiencing a treatment at the same time act as a control for towns that experience a treatment.

Because our theoretical analysis suggests that, in ban states, changes in state tax differentials affect $\Delta_{i,t}$ differently in high-tax and low-tax states (cf. (11a) and (11b)), we split the sample and show results for only high-tax towns ($H_{i,t} = 1$) initially. Instead, in no ban states, changes in tax differentials affect $\Delta_{i,t}$ qualitatively in the same way (cf. (12a) and (12b)). For this reason, we initially pool towns for $H_{i,t} = 1$ and $H_{i,t} = 0$ although we will relax this assumption subsequently. Moreover, we only report coefficients on the balanced dummies, which means we can only utilize tax shocks that occur at the middle of our sample. This leaves us with six tax changes for municipalities in ban states that are on the high-tax side and eleven tax changes in no ban states.

Figure 5 illustrates the results of our event study and confirms the signs from our theory. First, in high-tax ban states, localities lower local sales taxes to fight tax avoidance. In no ban states, the sign is positive. The latter positive sign arises, according to theory, because towns on the high-tax side of borders change the destination-based use tax rate more intensely than the origin-based sales tax rate to fight tax evasion while towns on the low-tax side simply raise the origin-based tax rate to take advantage of the inflow of cross-border shoppers. Moreover, and critically, it shows no pre-trends in the dependent variable prior to the reform. The fact that $\Delta_{i,t}$ was not trending prior to the tax reforms strengthens the case for exogeneity of the tax shocks, which reduces the concern that state tax changes are correlated with unobserved time varying characteristics of the municipality. Following the reform, taxes in both sets of states appear to adjust almost contemporaneously, which verifies the implicit assumption in the subsequent analysis. To interpret the magnitudes, in no ban states, the average state tax differential change is 0.86 percentage points, so that the post-reform coefficient estimates from the event study are about one-half of this magnitude. In ban states the average change in $\Lambda_{i,t}$ is 0.91 percentage points, so the event study post-reform coefficients are also about one-half of the average reform's size. Municipal responses do not entirely offset state policy changes.

3.2 Panel data model

While visually appealing, the event study cannot easily address some econometric concerns which is why, we now turn to a fixed effect regression. In what follows, we discuss four potential caveats of our previous analysis that we address here.

First of all, in our event study design, we only utilize tax shocks that occur at the middle of our sample in order to keep the event dummies balanced and do not account for the size of the treatment. The fixed effect regression allows us to use the full set of events and to formally account for the size of the changes. Hence, we utilize all 21 tax reforms in ban states and all 24 tax reforms in no ban states.

Second, although it is rather unlikely that states respond to individual municipal tax rate changes, one might worry about this identifying assumption due to the possibility of vertical tax competition with large municipalities or, perhaps more likely, common unobserved state and local shocks. To strengthen the case for exogeneity, we instrument for $\Lambda_{i,t}$ with $T^n_{i,t}$.[21] Concerning the relevance of the instrument, $T^n_{i,t}$ is strongly correlated with $\Lambda_{i,t}$ because it enters directly into this expression. Indeed, the F-statistic in our regressions implies that our instrument is strong. Although we cannot directly verify whether the exclusion restriction is met, the use of $T^n_{i,t}$ as an instrument certainly weakens vertical tax competition as a source of endogeneity. Moreover, given $T^n_{i,t}$ is the tax rate of another state, it is less likely to be subject to any common unobserved shocks within the actual state of town i that affect both the municipality and own-state. Nonetheless, it remains possible that neighboring states are hit by shocks that also affect municipalities in nearby states. We reduce this possibility by controlling for a full vector of neighboring

[21] Parchet (2018) uses a similar argument in the Swiss setting which requires that neighboring cantonal tax rates are exogenous in the local tax competition game. The basic idea is that changes in the neighboring canton's tax rate are not correlated with other unobservable changes in municipality i.

state controls ($\mathbf{Z^n}_{i,t}$). Furthermore, using neighboring state tax rates as an instrument eliminates the possibility that municipality i's own-state contemporaneously passed other tax reforms that affect the municipal sales or use tax rate of towns.

Third, local sales and use tax rates sometimes remain unchanged, i.e. municipalities only occasionally reform their tax laws. Although we have monthly data, we use only data for December of each year in the regression. Furthermore, and similar to Devereux, Lockwood and Redoano (2007), we include the time lagged dependent variable, $\Delta_{i,t-1}$. We instrument for this variable following Arellano and Bond (1991).[22]

Finally, given the comparative statics are of different signs for various sub-groups, we split our sample into four sets of municipalities: municipalities in relatively high-tax states that ban local use taxes, equation (11a); municipalities in relatively low tax states that ban local use taxes, (11b); municipalities in high-tax states that are allowed to set use tax rates, (12a); and municipalities in low-tax states that are allowed to set use tax rates, (12b). Although some of these subsamples have the same signed comparative statics, we analyze each of them separately because – as suggested by theory – the mechanisms and magnitudes may differ. Our preferred option is to split the sample based on the contemporaneous $H_{i,t}$ status given our model does not provide predictions when $T_{i,t} - T^n_{i,t}$ changes sign. Such a split sample means we will not utilize the three tax changes in ban states which cause a switch in the tax status when identifying our effects. The consequence of excluding these tax changes is an unbalanced panel for some border municipalities. As discussed in the appendix, our results are robust to defining $H_{i,t}$ in the first period of our sample and then holding this status constant throughout the sample.

For town i in year t we estimate a model of the form

$$\Delta_{i,t} = \nu_t + \zeta_i + \alpha\Delta_{i,t-1} + \gamma\Lambda_{i,t} + \mathbf{X}_{i,t}\beta + \varepsilon_{i,t}, \tag{16}$$

where the definitions of the variables are as in our event study. We focus on $\Delta_{i,t}$ rather than the sales and use tax rates separately because municipalities set both rates simultaneously. Studying only one of these rates would require controlling for the other rate, which by definition is endogenous without a plausible instrument. Using $\Delta_{i,t}$ avoids this issue by capturing effects on both sales and use taxes in a single variable.[23]

[22]Devereux, Lockwood and Redoano (2007) deal with this issue by including the second lag of the dependent variable in the instrument set. We formally implement this using the Arellano and Bond (1991) difference GMM estimator where the municipality fixed effects are removed using orthogonal deviations (Arellano and Bover 1995). We use two-step estimation with Windmeijer-corrected cluster–robust errors at the county level to capture correlation due to spatially proximate tax competition. We use the lags that are two-periods and higher as instruments for the lagged dependent variable. All other independent variables are assumed to be exogenous with the exception of our state level tax shocks, which we instrument as discussed previously.

[23]Table A.2 shows the effect of the tax shocks on the local sales and use tax rates separately. In principal, results show the correct signs and relative magnitudes, but are generally not statistically significant. However, these regressions should be interpreted with caution.

An alternative specification exploits how the differential $\Delta_{i,t}$ varies across space in response to exogenous shocks in a borders-based framework (Holmes 1998; Lovenheim 2008). Define Φ_i as the fastest driving time from the population weighted centroid to the nearest major road crossing of that state border. We expect the effects of tax avoidance to decline as distance from the border increases. We test how $\Delta_{i,t}$ varies across space following changes in shocks $\Lambda_{i,t}$ by interacting the shock with an M degree polynomial:

$$\Delta_{i,t} = \nu_t + \zeta_i + \alpha\Delta_{i,t-1} + \gamma\Lambda_{i,t} + \lambda\Lambda_{i,t} \times \sum_{m=1}^{M} (\Phi_i)^m + \mathbf{X}_{i,t}\beta + \varepsilon_{i,t}. \tag{17}$$

This specification can verify that the empirical effects we identify result from tax competition and tax avoidance. Border municipalities face tax differentials that are very salient to their residents and these municipalities should be the most responsive. Varying effects across distance also help to rule out any other state level shocks or possible coordination between states and localities that may affect all municipalities. While effects should decline with distance, note that our model does not predict that the effects should converge to zero. The reason is that $\Lambda_{i,t}$ depends on the own-state tax rate, which according to equations (13) and (14) will continue to affect municipalities at the interior of the state due to the presence of online shopping as a means of tax avoidance. To address this issue, for towns that are more than an hour from the nearest state border, we estimate a variant of equation (16) that uses own-state tax changes $T_{i,t}$ rather than $\Lambda_{i,t}$. If consumers in these interior municipalities buy from a vendor that does not have presence in the state, they can avoid the sales tax and may subsequently evade the use tax if the probability of detection is low. When the state tax rate increases, the incentive to buy online increases and our model applies even if the towns are located in a low-tax state. For specifications using $T_{i,t}$, we focus on towns more than an hour from the border given we do not model cross-border shopping and only consider online shopping to derive (13) and (14). We instrument for $T_{i,t}$ with the average neighboring state tax rate.

Given theory, we separately identify the effect of changes in $\Lambda_{i,t} = \left|T_{i,t} - T^n_{i,t}\right|$ on municipalities in ban (Iowa, Illinois, Mississippi, New Mexico, Vermont) and no-ban states (Alaska, Alabama, Arizona, Colorado, Missouri, Oklahoma). There are five states with use tax bans and six states where municipalities are allowed to set a positive use tax rate that differs from the sales tax rate. This raises a potential concern that these states are selected in a nonrandom way, and that the determinant of selection is affecting either tax setting or the ability of consumers to cross-border shop. In terms of our analysis, this could either be a confounding variable, or it could have implications for how relevant the results are for other states. No ban states are generally more remote with less opportunity for purchasing across state lines. At the same time, given their remoteness, towns in these states may be more likely to utilize online shopping as a means of tax avoidance. The smaller population of these states also means that these states have, on average, lower state tax rates. Due to these selection concerns, we rely on guidance from the theoretical model to justify the external validity of the empirical exercise. Extending the *magnitudes* of the results to other states would require that these selection concerns are minimal. While this requirement might not be satisfied, we believe the *signs* of the effects – because theoretically grounded – can be extended to other states that may allow local use tax autonomy in the future.

3.3 Results

Table 4 presents the results using $\Lambda_{i,t}$ as in (16). Recall from Proposition 3 that the expected sign depends on whether the state has a ban or does not have a ban on use tax setting. Further, within ban states, the effect is expected to be of opposite signs on the high-tax and low-tax side of the border. These asymmetries help strengthen identification in our paper as any unobserved shock that is correlated with the outcome variable and the explanatory variable must then have an opposite signed effect for towns on the high-tax side of the border in "ban" and "no ban" states. For easier reference to our theoretical results, Table 4 includes a column containing the expected sign.

In column (1) of Table 4, in states with use tax bans, an increase in state sales tax differentials by one percentage point *lowers* Δ by 0.59 percentage points if the town is on the high-state-tax side but raises Δ by 0.74 percentage points if the town is on the low-state-tax side. Because use taxes are banned, the decline in Δ can be fully attributed to the origin-based sales tax. Absent the ability to use the use tax, an increase in the state tax differential raises cross-border shopping and evasion incentives for residents of high-tax states and these towns fight this by lowering the only tax instrument available. For towns on the low-tax side, an increase in the tax differential increases the inflows of cross-border shoppers and expands the tax base; these towns raise their sales tax rate.

In states that allow municipalities to flexibly set local use tax rates, a one percentage point increase in the state tax differential at the border, *raises* Δ by 0.88 percentage points on the high-tax side, which is approximately 31% of the average local sales tax rate in these states. This result matches our theory in high-tax states. Instead, a one percentage point increase in the state tax differential lowers Δ by 0.04 percentage points on the low-tax side, or approximately 1% of the average local sales tax rate. The results in low-tax states are economically very small, and may be explained by the fact that our theoretical results for border municipalities on the low-tax side are ambiguous once we take the possibility of online shopping into account. Recall that, a reduction in T_l will increase Δ_l according to (12b), whereas, on the other hand, it decreases Δ_l according to (14). A possible explanation for why Δ_l is negatively affected might be that "no ban" states are generally more remote, possibly with less opportunities for purchasing across state lines, which implies that the effect of online shopping dominates. The empirical results across high-tax and low-tax states suggest that municipalities utilize sales and use tax rates to different degrees in order to respond to tax shocks.

Subsequent columns present various model variants.[24] In columns (3) and (4), we focus on "extensive" and "intensive" margins of response. Recall that approximately 40% of towns in these states set the destination-based rate equal to the origin-based rate. Many of these are towns elect to set both rates to zero. The effects of our model will only be present when the municipality actually has the ability to adjust its use rate. In column (3), we first estimate a linear probability model where the dependent variable is equal to one if the use tax rate does not equal the sales tax rate and is zero otherwise. In column (4), we separately estimate equation (16) restricting the sample to the towns in which $\Delta_{i,t} \neq 0$ for all periods in the sample. This is informative as to whether jurisdictions compete by simply setting the two taxes differently from each other or compete in the size of the difference between the two tax rates. In column (3), a change in the tax differential generally has no statistically significant effect on whether the sales or use tax differ. However, conditional on setting different use tax rates (column (4)), a change in the state induced cross-border shopping opportunities substantially changes the difference between the local sales and use tax rates. This suggests that places that set their use tax rate equal to the sales tax rate have some inertia in changing this, and that the results are mainly driven by towns for which the rates are historically different.

To strengthen the case for identification, we interact the state tax rate differentials with a polynomial in driving time to the border. For our baseline specification we use a quadratic polynomial. Table 5 presents the marginal effect of a change in the tax differential conditional on various distances to the border (0, 30, 60, 90, and 120 minutes from the nearest state border). In general, the magnitudes of the marginal effects decreases as distance to the border increases. However, although our effects decay with distance, they do not converge to zero. Hence, for towns that are far away from the border, individuals might have other tax avoidance opportunities. One opportunity of individuals living at the interior of a state is cross-border shopping to another municipality within the same state.[25] A second opportunity is to engage in sales-tax-free online shopping from firms without nexus in the state. Indeed, over the course of our sample, tax-free online shopping was an important component of tax avoidance (Goolsbee 2000; Einav et al. 2014). Analytically, an increase in $T_{i,t}$, will increase the incentives to engage in online shopping

[24] In column (2), we exclude towns with a population size of less than 500 people. The reason for excluding small towns is that they likely don't have many retail sales while our model applies moreso to towns in which individuals have the opportunity to purchase in their home town. Results are similar.

[25] The possibility of within-state cross-border shopping does not affect Propositions 3 and 4 and thus we do not expect this channel to influence our empirical results; see footnote 18.

which, in turn, gives towns located away from a state border the incentive to adjust their local tax rates. Given an increase in the state tax differential $T_{i,t} - T_{i,t}^{n}$ may be due to $T_{i,t}$, online shopping may explain the results persisting for interior towns.

To test whether online shopping might indeed be a channel that affects local commodity tax rate setting, we study the effect of how changes in the own-state tax rate, $T_{i,t}$, affect $\Delta_{i,t}$ in towns sufficiently far away from the border. We verify whether these results are consistent with the comparative statics in equations (13) and (14). If online sales are tax-free, every state is considered as high-tax relative to the Internet and we pool towns irrespective of their tax status $H_{i,t}$. An immediate advantage of this approach is the increase in sample sizes due to the ability to pool high-tax and low-tax borders.

Table 6 shows that, in ban states, a one percentage point increase in the own-state tax rate lowers the local sales tax rate by 0.93 percentage points. However, in no ban states, a similar tax shock raises the difference between the local sales and use tax rate by 0.59 percentage points. These results are generally unchanged in the subsequent columns of the table in which we drop small towns, estimate a linear probability model and restrict the sample to towns with $\Delta_{i,t} > 0$. An implication of the latter result is that towns utilize the destination-based use tax to fight evasion on online sales, but in doing so, cannot fully exploit destination-based taxation at the "full" origin-based tax rate. This finding, derived because of leakages from remote transactions during our sample, also helps justify non-zero local use tax rates in relatively low-tax states.

In conclusion, the lack of a use tax intensifies sales tax competition, while the ability to set use taxes results in the use tax (and not just the sales tax) being used as a fiscal policy instrument by the municipality. This results in municipalities implementing a commodity tax system that features destination-based taxation albeit at a lower than the "full" (sales) tax rate and suggests that audit probabilities are low in many towns.

4 Conclusion

We have shown that tax evasion and tax avoidance play separate roles on origin and destination-based commodity taxes, which are both present in the U.S. system. The local use tax can be actively used by local governments to engage in tax competition in the presence of cross-border shopping. However, in other circumstances such as the presence of use tax bans, the use tax will not be used and tax competition will occur through sales taxes. Exploiting plausibly exogenous shocks to state policies, we show that the difference between sales and use tax rates is responsive to the shocks in a manner broadly consistent with our theoretical model. In high-tax states, exogenous shocks increasing the incentives for cross-border shopping increase the difference between sales and use taxes when jurisdictions can set both rates, but decreases the sales tax rate when use tax bans are in place. In low-tax states, our results are consistent with theory, despite finding approximately zero effects when low-tax jurisdictions set both rates. This result can be explained by the presence of both online shopping and cross-border shopping.

Our paper shows that the ability to set both destination and origin-based components at different rates is welfare improving for local governments and municipalities utilize this added flexibility when granted. Absent administrative considerations, it is sub-optimal for a state to constrain municipalities to one single rate. Because most tax systems have a combination of origin and destination-based components our model could be used to help understand other taxes.

From a policy perspective, unless there is a change in the enforcement technology, the incentives of auditors, the resources devoted to enforcement, or the salience of detection, detection probabilities are likely to remain low and destination-based taxation at the full (sales tax) rate is undesirable. One potential solution to achieving destination taxation at the full sales tax rate – widely used for other tax bases – is to exploit third-party reporting, which in the context of commodity tax competition may require information on credit/debit card transactions. For example, Colorado law recently required online firms that do not collect sales taxes to report these sales to the revenue department. Albeit not reporting to the government, Amazon previously agreed to send a list of sales to each purchaser in Tennessee noting that use taxes may be due. Although technologically possible, allowing for broad third party information reporting using credit card data may face political obstacles. In terms of online sales, another alternative to achieve full destination taxation would be passage of national legislation consistent with the recent *South Dakota v. Wayfair* Supreme Court decision, such as the Marketplace Fairness Act, which requires online firms to remit taxes regardless of whether they have physical nexus in a state, and instead, rely on economic nexus. Despite being a first step, such a reform would not eliminate tax evasion because cross-border shopping will remain an important channel for use tax evasion. However, until such reforms are adopted, the use tax rate and *de minimis* exemptions in the VAT context will remain important instruments for confronting tax evasion.

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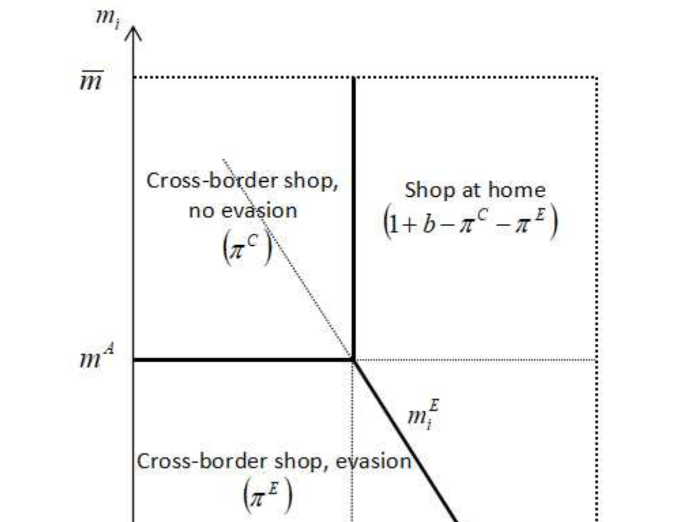
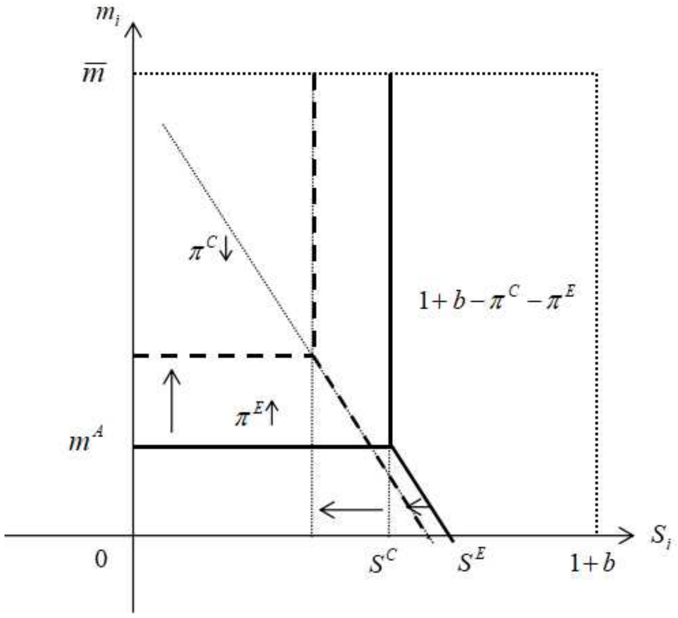
Figure 1: Equilibrium shopping behavior with honest and evading individuals



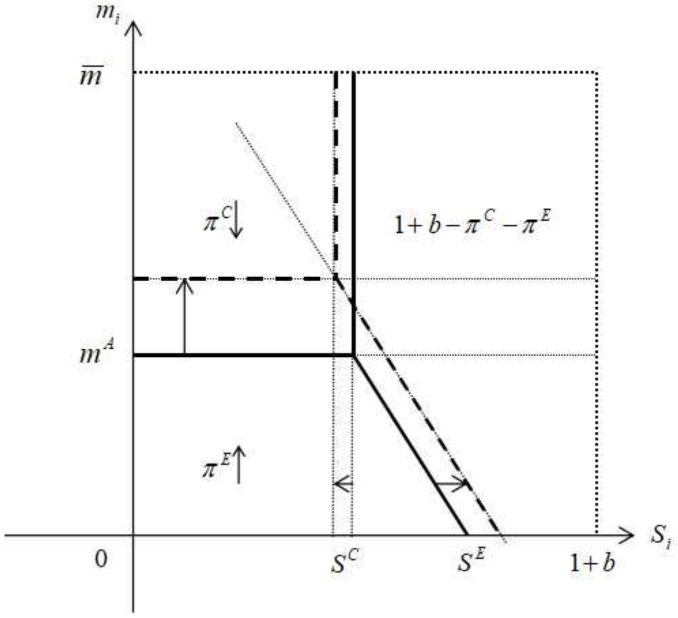
The figure shows the equilibrium for a border municipality in the high-tax state. All variables are defined in Table 3.

Figure 2: Change in individuals' shopping behavior following an increase in the local use tax rate



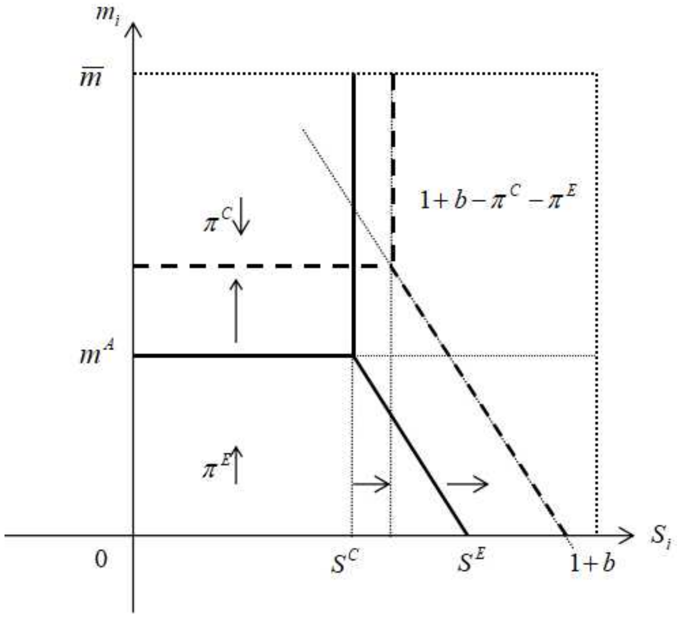
All variables are defined in Table 3. The initial equilibrium is drawn in bold solid lines; the adjustments following an increase in the local use tax rate by the municipality are drawn with bold dashed lines. The increase in the local use tax rate shifts the m^A line up and the m_i^E line and the S^C line to the left. As a consequence use tax evasion π^E increases.

Figure 3: Change in individuals' shopping behavior in municipalities with a ban following an increase in the state sales tax rate differential



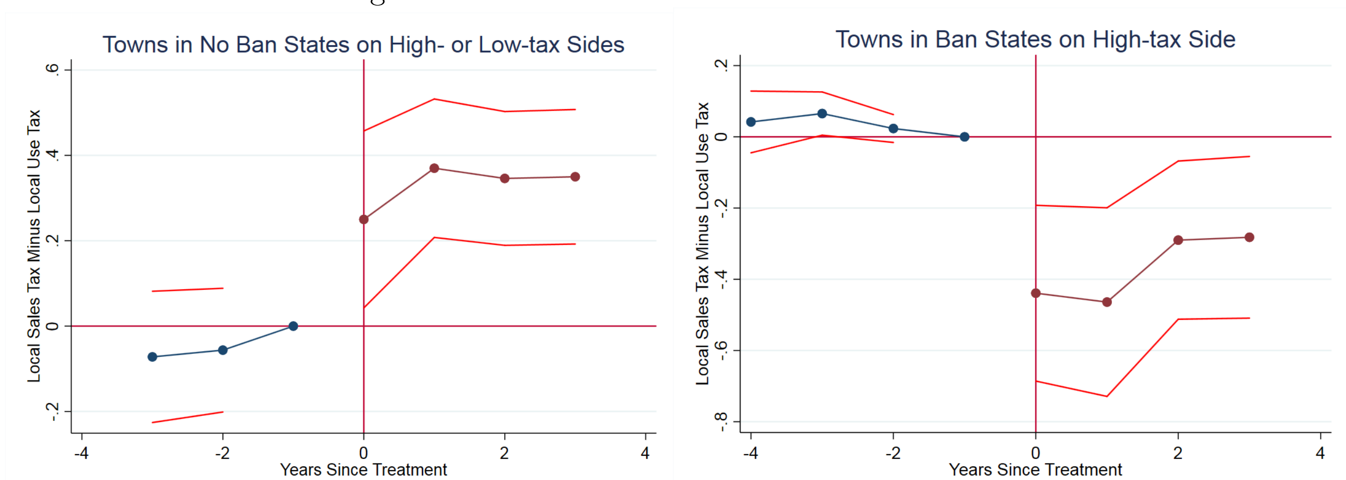
All variables are defined in Table 3. The initial equilibrium is drawn in bold solid lines; the equilibrium following the increase in the state sales tax differential and adjustments by the municipality is drawn with bold dashed lines. The increase in the state sales tax differential shifts out both the m^A and the m_i^E line but leaves unaffected the S^C line (not displayed). As a consequence municipality h reduces its sales tax rate (inclusive of tax competition). This shifts the S^C line to the left. The m_i^E and the m^A lines partially shift back because the reduction in the local sales tax differential $(t_h - t_l)$ only partially offsets the initial increase in the state sales tax differential.

Figure 4: Change in individuals' shopping behavior in municipalities without a ban following an increase in the state sales tax rate differential



All variables are defined in Table 3. The initial equilibrium is drawn in bold solid lines; the equilibrium following the increase in the state sales tax differential and adjustments by the municipality is drawn with bold dashed lines. The increase in the state sales tax differential shifts out both the m^A and the m_i^E line but leaves unaffected the S^C line (not displayed). Both municipalities adjust their commodity tax rates. Inclusive of tax competition, this results in a reduction of the local use tax rate by more than the local sales tax rate. This shifts the S^C line to the right. The m^A line partially shifts back because the reduction in the local sales tax differential $(t_h - t_l)$ only partially offsets the initial increase in the state sales tax differential. Instead, the m_i^E line is shifted out further.

Figure 5: Effect of the state tax differential on Δ



This figure shows the effect of an increase in the state sales tax rate differential on the difference in the sales tax minus the use tax at the municipal level. The left figure is for towns in states that allow municipalities to set both a sales and use tax rate; we pool towns in high-tax and low-tax states. The figure on the right is for municipalities in states that allow municipalities to only set a sales tax rate and so the local differential is simply equal to the local sales tax rate; here we focus on towns in high-tax states only. The expected sign of the reform is positive in no ban states (see (12a) and (12b)) and negative in ban high-tax states (see (11a)). The zero line is given by the solid horizontal line: note the difference in the vertical axis on both graphs. Standard errors are clustered at the county level and the figure shows 90% confidence intervals; period -1 is the omitted category so no confidence bands are included.

Table 1: Summary statistics for tax rates

Tax	Unweighted			Population Weighted		
	all months	9/2003	12/2011	all months	9/2003	12/2011
A. Towns in All States Allowing For Local Taxation						
Total Local Sales Tax	1.53	1.37	1.58	1.85	1.68	1.98
	(1.43)	(1.38)	(1.49)	(1.45)	(1.38)	(1.49)
Total Local Use Tax	1.19	1.09	1.24	1.54	1.45	1.59
	(1.40)	(1.32)	(1.44)	(1.45)	(1.41)	(1.49)
Number Where Local Sales Tax $\neq$ Local Use Tax	341,541	3,172	3,444	341,907	3,175	3,449
Total Number Observations	1,826,232	18,401	18,429	1,826,232	18,401	18,429
B. Towns in States Allowing For Different Rates on Sales and Use Taxes (No Ban)						
Total Local Sales Tax	2.95	2.70	3.18	3.51	3.21	3.71
	(1.51)	(1.44)	(1.57)	(1.23)	(1.14)	(1.26)
Total Local Use Tax	1.50	1.32	1.67	2.08	2.16	1.78
	(1.82)	(1.69)	(1.94)	(1.87)	(1.73)	(1.98)
Number Where Local Sales Tax $\neq$ Local Use Tax	163,062	1660	1591	163,062	1660	1591
Total Number Observations	262,678	2610	2641	262,678	2610	2641

The table shows the average local sales and use tax rate (county + town + district) for all time periods (over all one-hundred months) and for the first and last month of the sample. The first panel restricts each time period to the set of states that allows for local sales taxation at one or more levels of local government (i.e., it excludes towns in states where only the state levies sales taxes). In other words, the first panel includes towns in states where localities set the local sales and use tax equal, states where localities are banned from setting use taxes, and states where localities have autonomy to set both rates at different levels. The second panel focuses on the six states where localities are allowed to flexibly set sales and use tax rates at different levels. Standard deviations are given in parenthesis. The weighted results are weighted by the town population in the 2010 Census. All calculations are based on our sample of matched towns to Census places.

Table 2: Fraction of towns with sales taxes not equal to use taxes by state

State	9/2003			12/2011		
	Percent with Sales Tax > Use Tax	Percent with Sales Tax < Use Tax	Average Differential (including zeros)	Percent with Sales Tax > Use Tax	Percent with Sales Tax < Use Tax	Average Differential (including zeros)
Alabama	24.34	0	.41	15.50	0	.28
Alaska	39.65	0	1.16	40.56	0	1.41
Arizona	95.45	0	1.46	100	0	1.60
Colorado	91.67	0	2.56	94.20	0	3.18
Illinois (ban)	47.36	0	.35	61.97	0	.73
Iowa (ban)	79.20	0	1.10	94.93	0	.94
Mississippi (ban)	.003	0	≈ 0	.003	0	≈ 0
Missouri	88.39	0	1.69	89.91	0	2.09
New Mexico (ban)	98.64	0	1.20	100	0	1.98
Oklahoma	39.59	0	1.02	25.46	0	.66
Vermont (ban)	3.13	0	≈ 0	7.81	0	≈ 0

The table shows the percent of towns in our sample with a total sales tax rate (county + town + district) greater than and less than the local use tax rate. The unaccounted percent of towns in the table has a local use tax rate equal to the local sales tax rate. The average differential is the total sales tax rate minus the total use tax rate. All calculations are based on our sample of matched towns to Census places. States not listed in the table always have the local sales and use tax equal to each other. States with the notation (ban) do not allow local use taxes so the share of towns with sales taxes greater than use taxes is equal to the share of towns with non-zero sales tax rates.

Table 3: Notation for theoretical model

Variable	Definition
t_i	Local sales tax rate.
τ_i	Local use tax rate.
T_i	State sales tax rate.
Γ_i	State use tax rate
b	Jurisdiction size parameter.
p	Probability of detection.
f	Fine.
δ	Transport cost.
m_i	Person-specific cost of use tax evasion.
S^C	Distance of honest individual indifferent between purchasing at home or abroad.
S^E	Distance of potentially evading individual indifferent between purchasing at home or abroad if $m_i = 0$.
m_i^E	Individual specific threshold below which individual with $S_i > S^C$ evades if she purchases abroad.
m^A	Threshold below which the use tax is evaded for individuals with $S_i \leq S^C$.
π^E	The expected number of evading cross-border shoppers.
π^C	The expected number of compliant cross-border shoppers.
λ	The weight given to revenue in the welfare function.
Δ	The local sales tax rate minus the local use tax rate.

Table 4: Effect of state tax differential shock on Δ

Use Tax Policy	Side of Border	Theory (only cross-border)	(1)	(2)	(3)	(4)
Ban Use Taxes	High-Tax	< 0	-0.585***	-0.485***	-0.047	-0.285***
			(0.104)	(0.123)	(0.046)	(0.085)
	Low-Tax	> 0	0.735***	0.768***	0.003	0.901***
			(0.068)	(0.084)	(0.017)	(0.118)
Allow Use Taxes	High-Tax	> 0	0.879*	0.978***	-0.013	1.340
			(0.530)	(0.371)	(0.094)	(1.935)
	Low-Tax	> 0	-0.039*	-0.055**	-0.010**	-0.023
			(0.020)	(0.026)	(0.050)	(0.023)
		Time FE?	Y	Y	Y	Y
		Town FE?	Y	Y	Y	Y
		Controls?	Y	Y	Y	Y

Each *cell* represents a separate regression estimating (16) split by state use tax policy status and high/low-tax side of the border. The theoretically expected signs of each subsample, in the presence of cross-border shopping only, are given by equations (11a) to (12b). When combining online shopping and cross-border shopping, all signs are the same except for low-tax states allowing for use taxes, where theory predicts it may be $\gtreqless 0$. Except for column (3), the dependent variable is the total local sales tax rate minus the total local use tax rate. All models are estimated using data from December of each year from 2003 to 2011. The model contains time fixed effects and town fixed effects and local controls, state-level controls, and neighboring state level controls. A time lagged dependent variable is included and appropriately instrumented for. The independent variable is the state sales tax rate differential defined as the absolute value of the state tax rate minus the nearest neighboring state sales tax rate. We instrument for this with the neighboring state tax rate. Column (1) estimates the baseline specification. Column (2) drops small towns with populations below 500. Column (3) is a linear probability model with the dependent variable equal to one if the use tax and sales tax are not equal and zero otherwise. Column (4) restricts the sample to towns with $\triangle_{i,t} > 0$. All standard errors in ( ) are clustered at the county level to account for local tax competition. ***99%, **95%, and *90%.

Table 5: Effect of state tax differential shock by distance

Use Tax Policy	Side of Border	Theory (only cross-border)	$\Phi_i = 0$	$\Phi_i = 30$	$\Phi_i = 60$	$\Phi_i = 90$	$\Phi_i = 120$
Ban Use Taxes	High-Tax	< 0	-0.743	-0.652***	-0.581***	-0.532**	-0.504**
			(0.577)	(0.211)	(0.146)	(0.211)	(0.250)
	Low-Tax	> 0	1.049***	0.889***	0.758***	0.654***	0.578
			(0.243)	(0.112)	(0.068)	(0.093)	(0.113)
Allow Use Taxes	High-Tax	> 0	1.120**	1.009*	0.861*	0.754	0.688
			(0.601)	(0.547)	(0.511)	(0.488)	(0.475)
	Low-Tax	> 0	-0.029	-0.031	-0.035*	-0.040*	-0.0474*
			(0.035)	(0.024)	(0.019)	(0.021)	(0.026)

Each *row* represents a separate regression estimating (17) split by state use tax policy status and high/low-tax side of the border. The columns give the marginal effect of a tax differential change conditional on being at distance Φ_i (in minutes). The theoretically expected signs of each subsample, in the presence of cross-border shopping only, are given by equations (11a) to (12b). When combining online shopping and cross-border shopping, all signs are the same except for low-tax states allowing for use taxes, where theory predicts it may be $\gtrless 0$. The dependent variable is the total local sales tax rate minus the total local use tax rate. All models are estimated using data from December of each year from 2003 to 2011. The model contains time fixed effects and town fixed effects and local controls, state-level controls, and neighboring state level controls. A time lagged dependent variable is included and appropriately instrumented for. The independent variable is the state sales tax rate differential defined as the absolute value of the state tax rate minus the nearest neighboring state sales tax rate. This variable is interacted with a second-order polynomial in distance. We instrument for this with the neighboring state tax rate and any interaction with distance with the neighboring state tax rate by the polynomial in distance. All standard errors in ( ) are clustered at the county level to account for local tax competition. ***99%, **95%, and *90%.

Table 6: Effect of own-state tax rate change on on Δ in the presence of online shopping

Use Tax Policy	Side of Border	Theory (only online)	(1)	(2)	(3)	(4)
Ban Use Taxes	High-Tax and Low-Tax	< 0	-0.925***	-0.892***	-0.305***	-1.101***
			(0.077)	(0.089)	(0.091)	(0.122)
Allow Use Taxes	High-Tax and Low-Tax	> 0	0.589**	0.424*	0.032	0.201
			(0.252)	(0.238)	(0.055)	(0.197)
		Time FE?	Y	Y	Y	Y
		Town FE?	Y	Y	Y	Y
		Controls?	Y	Y	Y	Y

Each *cell* represents a separate regression estimating a variant of (16) split by state use tax policy status. The independent variable of interest replaces $\Lambda_{i,t}$ with the own-state sales tax rate. The theoretically expected signs of each subsample, in the presence of online shopping, are given by equations (13) to (14). Except for column (3), the dependent variable is the total local sales tax rate minus the total local use tax rate. All models are estimated using data from December of each year from 2003 to 2011. The model contains time fixed effects and town fixed effects and local controls, state-level controls, and neighboring state level controls. A time lagged dependent variable is included and appropriately instrumented for. We instrument for the own-state tax rate with the average neighboring state tax rate. Given the theoretical model contains only online shopping and no cross-border shopping we restrict the sample only to towns at the interior of the state. Column (1) estimates the baseline specification. Column (2) drops small towns with populations below 500. Column (3) is a linear probability model with the dependent variable equal to one if the use tax and sales tax are not equal and zero otherwise. Column (4) restricts the sample to towns with $\triangle_{i,t} > 0$. All standard errors in ( ) are clustered at the county level to account for local tax competition. ***99%, **95%, and *90%.

A Appendices (for online publication only)

A.1 Use tax revenues and survey of states

We found sales and use tax revenue reported separately on several state websites. In 2012, the state of Michigan collected 1.4 billion in use tax revenues and 7 billion in sales tax revenues. In 2014, in Minnesota, the state and its localities collected 0.5 billion in use tax revenues and 5 billion in sales tax revenues. In 2010, Wyoming – state and counties – collected 87 million in use tax revenue and 700 million in sales tax revenue. In 2015, in Oklahoma, across all levels of government, use tax collections were just under 0.5 billion while sales tax collections were 4.5 billion. In Missouri, in 2014, the use tax had 9 billion dollars of reported taxable transactions (note, not revenue) and the sales tax had 73 billion dollars of taxable transactions.

Table A.1 describes the results of our state survey. Some states are worthy of mention as external websites may classify their local use tax regulations differently than we do or their current status is different from the time period we study empirically: Pennsylvania,[26] Wisconsin,[27] Vermont,[28] and Idaho.[29]

[26]We found third-party websites that classify Pennsylvania as a ban state, however, the state writes "When Pennsylvania sales tax is not charged by the seller on a taxable item or service delivered into or used in Pennsylvania, the consumer is required by law to report and remit use tax to the Department of Revenue. The use tax rate is the same as the sales tax rate: 6 percent state tax, plus an additional 1 percent local tax for items purchased in delivered to or used in Allegheny County and 2 percent local tax for Philadelphia." We thus code this appropriately.

[27]We found third-party websites that state that Wisconsin localities have flexibility to select the rate. However, the website writes "The county sales tax rate of 0.5% is imposed on retailers making taxable retail sales, licenses, leases, or rentals or providing taxable services in a Wisconsin county that has adopted the county tax. The county use tax rate of 0.5% is imposed on purchasers of items used, stored, or consumed in counties that impose county tax. County use tax must be paid when Wisconsin county sales tax is not charged and no exemption applies." This was clarified in email correspondence with the department of revenue: "Wisconsin local use tax rates are always the same as the Wisconsin sales tax rate." We thus code this state accordingly.

[28]The state of Vermont writes: "Although the local option tax is levied by the municipality, the vendor who collects this tax remits it to the Vermont Department of Taxes along with any state taxes. Any vendor who is located out of state and is registered to collect Vermont state business taxes must also collect local option tax where applicable. Local option tax does not apply to transactions that are subject to use tax or to motor vehicle purchase and use tax." Email correspondence notes "The local option tax collected by vendors is remitted to the Department at the same time that sales tax is remitted. The Department gathers uncollected local option sales tax on behalf of a municipality when it performs an audit and will forward that revenue to a municipality. However, when use tax is self-reported by individuals and paid through the personal income tax return, that revenue is not forwarded to local municipalities. Use tax is not included in local option tax enabling statute. Vermont law precludes a local option municipality from billing taxpayers for use tax." We thus code Vermont as a ban state.

[29]Some clarification for Idaho is in order given the rules in our data are different from current law. Email correspondence: "In 2003, the Idaho Legislature passed House Bill 428 (2003 Session Law Ch. 363 on page 969) which provided for a county sales and use tax. To enact such a tax it was necessary to hold an election which would have to pass with a 2/3 majority. County sales and use taxes were equivalent in this time period. The sunset clause attached to the bill stated that the law was in full force and effect on and after its passage and would be null and void on December 31, 2009. The Legislature did not extend the sunset date" and thus no county sales and use taxes are in force today. However, historically and at present, resort cities with a population less than 10,000, are allowed to set local-option taxes, however,

A.2 Data cleaning

The initial data on local use tax rates is provided to us by a proprietary firm, which collects the data from states and assembles them into a single usable file. The firm then sells these data to companies that need to remit taxes across multiple states. Although these data are provided to firms, they need substantial cleaning to be used for research purposes. The panel data are assembled in a similar manner as the sales tax data in Agrawal (2014). The raw data that we obtain contain no geographic identification numbers. The data contains only the town name, county name, and the zip code for the tax rate. In order to match this to observable demographic data and to determine the position of each town in geographic space, we match the tax data to the names of Census Places in the most recent American Community Survey (ACS). When doing this, we require the town name, county name, and state name to match. In general, town tax rates are constant within a town as are county tax rates. However, given that special districts may be sub-municipal, district taxes may vary within a town. To calculate the district tax in the town, we select the district tax rate that is most common in the town at the given year. As a robustness exercise, we exclude all district taxes from the analysis. Matching the data to Census Places means that some towns (mainly small towns) with taxing authority are not in our final data set, however, in order to proceed with the analysis we need to know about the municipalities. Unfortunately, no map files exist for all towns in the United States; the closest approximation is Census Places.

In the case where Census Places cross county lines, we assign the town to be within the county where the majority of the population lives. In order to determine this, we take a map of Census Block points and intersect this map with a map of Census Places and Census counties. We then sum the total population of the block points within each intersection of the place and the several counties it may span. We then assign the town to the county that contains the majority of its population. After cleaning the use tax data, we are able to match the use tax rates to local sales tax data assembled in Agrawal (2014) using the Census Place identification number.

In assembling the data, we noticed that occasionally, sales and use taxes are different from each other even in states where the survey indicate no differences in the sales and use tax rate. We check these discrepancies with published data on sales and use tax rates (if available). To the best of our knowledge these represent data entry errors. For example, in one jurisdiction, a rate of 6.5 was entered instead of 0.65. In all states where we know local use and local sales tax rates are available, we correct these errors

they do not have use tax authority as they are granted this authority under different legislation. Thus, under current law, Idaho would be a ban state. Given that during our sample, the legislation differed for counties and localities, we exclude the state from our analysis.

by changing the local use tax rate to be equal to the local sales tax rate. In states where local sales and use taxes are allowed to differ, we verify that there are no unusually large differences in these tax rates and we correct observations where the difference in the sales and use tax arises for only a single month (we view this as a likely typographical error given that tax rates do not usually change two months in a row). Unfortunately, given that many states do not publish historical local use tax rates, we cannot clean all observations, however, we check our data with the data on some state websites. After the two data cleaning procedures noted above – taken in conjunction with the survey evidence – we are confident the data are capturing true differentials.

We merge the tax data to ACS control variables. At the town level, this requires using the five year estimates of the ACS. We assign the ACS five year estimates to our tax data by assigning it to December of the midpoint of the years spanned. These control variables in the five year estimates are useful for showing broad trends over time but not the precise timing of population or demographic shocks. No other disaggregated demographic variables are available at this level of geography at high frequency. The ACS was not available in 2003. To determine the values of the controls in 2003, we linearly interpolate between the 2000 Census and the first year the ACS was available. This approach avoids starting in the Great Recession. We also run results starting the data later and find similar signs. We include control variables at the municipal level in all regressions: population (log), percent male, percent senior, the median age, percent white, percent college degree educated, income (log), percent on public assistance, percent of non-citizens, percent working in state, the number of rooms in houses, the age of housing, the percent of people working in agriculture, and the ratio of public to private students.

A.3 Trade-offs of consumers in municipality h

In this section, we derive all consumer tradeoffs. If all individuals, are compliant an individual always declares the purchase and hence always pays the use tax on a cross-border purchase. Thus, cross-border shopping is beneficial if

$$V - 1 - \Gamma_h - \tau_h - \delta S_i \geq V - 1 - T_h - t_h,$$

$$\Leftrightarrow \quad \delta S_i \leq T_h + t_h - \Gamma_h - \tau_h = t_h - \tau_h.$$

A non-compliant individual will, instead of purchasing the good at home, shop abroad and evade the use tax if

$$V - 1 - \delta S_i - m_i - (1-p)(T_l + t_l) - p(\Gamma_h + \tau_h + f) \quad \geq \quad V - 1 - T_h - t_h,$$

$$\Leftrightarrow \quad m_i \leq t_h - \tau_h - \delta S_i + (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right) - pf \equiv m_i^E.$$

Conditional on purchasing the good in the foreign jurisdiction, an individual can decide to evade the use tax or be compliant and declare the purchase. It is only optimal for the individual to evade the use tax if

$$V - 1 - \delta S_i - m_i - (1-p)\left(T_l + t_l\right) - p\left(\Gamma_h + \tau_h + f\right) \geq V - 1 - \Gamma_h - \tau_h - \delta S_i,$$

$$m_i \leq (1-p)\left(\Gamma_h + \tau_h - T_l - t_l\right) - pf \ \equiv m^A.$$

A.4 Deriving consumer surplus in municipality h

In this section, we will derive consumer surplus in the large jurisdiction which is given by

$$\begin{aligned}
CS_h \;=\; & \left(1 + b - \pi^C - \pi^E\right)\left(V - 1 - T_h - t_h\right) + \int_0^{S^C}\int_{m^A}^{\bar{m}} \left(V - 1 - \Gamma_h - \tau_h - \delta S_i\right)\ g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i \\
+ & \int_0^{S^C}\int_0^{m^A} \left[V - 1 - \delta S_i - m_i - p\left(\Gamma_h + \tau_h\right) - (1-p)\left(T_l + t_l\right) - pf\right]\ g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i \\
+ & \int_{S^C}^{S^E}\int_0^{m_i^E} \left[V - 1 - \delta S_i - m_i - p\left(\Gamma_h + \tau_h\right) - (1-p)\left(T_l + t_l\right) - pf\right]\ g\left(m_i\right) \mathrm{d}m_i \mathrm{d}S_i.
\end{aligned}$$

The first term is the consumer surplus of all individuals that purchase the good in their home jurisdiction. These individuals will always pay municipality h's combined sales tax rate $T_h + t_h$. The second term captures surplus of compliant cross-border shoppers which pay the combined use tax rate $\Gamma_h + \tau_h$ instead of the combined sales tax rate $T_h + t_h$. The third and the fourth term comprise use tax evading cross-border shopping individuals who only have to pay municipality l's combined sales tax rate $T_l + t_l$ with probability $(1-p)$ but have to pay the combined use tax rate $\Gamma_h + \tau_h$ plus a fine if they get caught by the tax authority. Rearranging terms, using $T_h = \Gamma_h$, yields

$$\begin{aligned}
CS_h &= \left(1+b-\pi^C-\pi^E\right)(V-1-T_h-t_h) + \int_0^{S^C}\int_{m^A}^{\bar{m}} (V-1-T_h-t_h)\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \\
&+ \int_0^{S^C}\int_{m^A}^{\bar{m}} (t_h-\tau_h-\delta S_i)\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i + \int_0^{S^C}\int_0^{m^A} (V-1-T_h-t_h)\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \\
&+ \int_0^{S^C}\int_0^{m^A} (t_h-\tau_h-\delta S_i)\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \\
&+ \int_0^{S^C}\int_0^{m^A} \left[(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf-m_i\right]\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \\
&+ \int_{S^C}^{S^E}\int_0^{m_i^E} (V-1-T_h-t_h)\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i \\
&+ \int_{S^C}^{S^E}\int_0^{m_i^E} \left[t_h-\tau_h-\delta S_i+(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf-m_i\right]\ g(m_i)\,\mathrm{d}m_i\mathrm{d}S_i,
\end{aligned}$$

which simplifies after using integration by parts to

$$\begin{aligned}
CS_h &= (1+b)(V-1-T_h-t_h) + \frac{(t_h-\tau_h)^2}{2\delta} \\
&+ \int_0^{S^C} G\left(m^A\right)\left[(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf-m^A\right]\mathrm{d}S_i \\
&- \int_0^{S^C} G(0)\left[(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf\right]\mathrm{d}S_i \\
&+ \int_{S^C}^{S^E} G\left(m_i^E\right)\left[t_h-\tau_h-\delta S_i+(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf-m_i^E\right]\mathrm{d}S_i \\
&- \int_{S^C}^{S^E} G(0)\ \left[t_h-\tau_h-\delta S_i+(1-p)(\Gamma_h+\tau_h-T_l-t_l)-pf\right]\mathrm{d}S_i \\
&+ \int_0^{S^C}\int_0^{m^A} G(m_i)\,\mathrm{d}m_i\mathrm{d}S_i + \int_{S^C}^{S^E}\int_0^{m_i^E} G(m_i)\,\mathrm{d}m_i\mathrm{d}S_i.
\end{aligned}$$

Further simplification boils consumer surplus down to

$$CS_h = (1+b)(V - 1 - T_h - t_h) + \frac{(t_h - \tau_h)^2}{2\delta} + \int_0^{S^C}\int_0^{m^A} G(m_i)\,\mathrm{d}m_i \mathrm{d}S_i + \int_{S^C}^{S^E}\int_0^{m_i^E} G(m_i)\,\mathrm{d}m_i \mathrm{d}S_i,$$

as stated in equation (9a) in the main text.

A.5 Derivation of tax effects with avoiders and evaders

To discuss the first-order conditions in (10a)-(10c) we need the following derivations:

$$
\begin{aligned}
\frac{\partial \pi^C}{\partial t_h} &= \left[1-G\left(m^A\right)\right]\frac{\partial S^C}{\partial t_h} - S^C g\left(m^A\right)\frac{\partial m^A}{\partial t_h} = \frac{1}{\delta}\left[1-G\left(m^A\right)\right] > 0,\\
\frac{\partial \pi^E}{\partial t_h} &= G\left(m^A\right)\frac{\partial S^C}{\partial t_h} + S^C g\left(m^A\right)\frac{\partial m^A}{\partial t_h} + G\left(m_i^E\left(S^E\right)\right)\frac{\partial S^E}{\partial t_h} - G\left(m_i^E\left(S^C\right)\right)\frac{\partial S^C}{\partial t_h}\\
&+ \int_{S^C}^{S^E} g\left(m_i^E\right)\frac{\partial m_i^E}{\partial t_h}\mathrm{d}S_i = \frac{1}{\delta}G\left(m^A\right) > 0,\\
\frac{\partial \pi^C}{\partial \tau_h} &= \left[1-G\left(m^A\right)\right]\frac{\partial S^C}{\partial \tau_h} - S^C g\left(m^A\right)\frac{\partial m^A}{\partial \tau_h}\\
&= -\frac{1}{\delta}\left[1-G\left(m^A\right)\right] - (1-p)\,S^C g\left(m^A\right) < 0,\\
\frac{\partial \pi^E}{\partial \tau_h} &= G\left(m^A\right)\frac{\partial S^C}{\partial \tau_h} + S^C g\left(m^A\right)\frac{\partial m^A}{\partial \tau_h} + G\left(m_i^E\left(S^E\right)\right)\frac{\partial S^E}{\partial \tau_h} - G\left(m_i^E\left(S^C\right)\right)\frac{\partial S^C}{\partial \tau_h}\\
&+ \int_{S^C}^{S^E} g\left(m_i^E\right)\frac{\partial m_i^E}{\partial \tau_h}\mathrm{d}S_i = (1-p)\,S^C g\left(m^A\right) - \frac{p}{\delta}G\left(m^A\right) \lesseqgtr 0,\\
\frac{\partial \pi^C}{\partial t_l} &= \left[1-G\left(m^A\right)\right]\frac{\partial S^C}{\partial t_l} - S^C g\left(m^A\right)\frac{\partial m^A}{\partial t_l} = (1-p)\,S^C g\left(m^A\right) > 0,\\
\frac{\partial \pi^E}{\partial t_l} &= G\left(m^A\right)\frac{\partial S^C}{\partial t_l} + S^C g\left(m^A\right)\frac{\partial m^A}{\partial t_l} + G\left(m_i^E\left(S^E\right)\right)\frac{\partial S^E}{\partial t_l} - G\left(m_i^E\left(S^C\right)\right)\frac{\partial S^C}{\partial t_l}\\
&+ \int_{S^C}^{S^E} g\left(m_i^E\right)\frac{\partial m_i^E}{\partial t_l}\mathrm{d}S_i = -(1-p)\left[S^C g\left(m^A\right) + \frac{1}{\delta}G\left(m^A\right)\right] < 0,\\
\frac{\partial CS_h}{\partial t_h} &= -(1+b) + S^C + \mathcal{G}\left(m^A\right)\frac{\partial S^C}{\partial t_h} + \mathcal{G}\left(m_i^E\left(S^E\right)\right)\frac{\partial S^E}{\partial t_h} - \mathcal{G}\left(m_i^E\left(S^C\right)\right)\frac{\partial S^C}{\partial t_h}\\
&+ \int_{S^C}^{S^E} G\left(m_i^E\right)\mathrm{d}S_i = -(1+b) + S^C\left[1-G\left(m^A\right)\right] + S^C G\left(m^A\right)\\
&+ \int_{S^C}^{S^E} G\left(m_i^E\right)\mathrm{d}S_i = -\left(1+b-\pi^C-\pi^E\right) < 0,\\
\frac{\partial CS_h}{\partial \tau_h} &= -S^C + \mathcal{G}\left(m^A\right)\frac{\partial S^C}{\partial \tau_h} + \mathcal{G}\left(m_i^E\left(S^E\right)\right)\frac{\partial S^E}{\partial \tau_h} - \mathcal{G}\left(m_i^E\left(S^C\right)\right)\frac{\partial S^C}{\partial \tau_h}\\
&+ (1-p)\int_0^{S^C} G\left(m^A\right)\mathrm{d}S_i - p\int_{S^C}^{S^E} G\left(m_i^E\right)\mathrm{d}S_i = -S^C\left[1-G\left(m^A\right)\right]\\
&- p\left[S^C G\left(m^A\right) + \int_{S^C}^{S^E} G\left(m_i^E\right)\mathrm{d}S_i\right] = -\left(\pi^C + p\pi^E\right) < 0,
\end{aligned}
$$

where $\mathcal{G}(m_i)$ is the primitive of $G(m_i)$ and $\mathcal{G}(0) = 0$. Moreover, in order to prove our Propositions we also need the following derivatives

$$\begin{aligned}
\frac{\partial \pi^C}{\partial T_h} &= -\frac{\partial \pi^C}{\partial T_l} = -(1-p) S^C g\left(m^A\right) < 0, \\
\frac{\partial \pi^E}{\partial T_h} &= -\frac{\partial \pi^E}{\partial T_l} = (1-p)\left[S^C g\left(m^A\right) + \frac{1}{\delta} G\left(m^A\right)\right] > 0,
\end{aligned}$$

$$\begin{aligned}
\frac{\partial^2 \pi^C}{\partial t_h \partial T_h} &= \frac{\partial^2 \pi^E}{\partial t_h \partial T_l} = \frac{\partial^2 \pi^C}{\partial \tau_h \partial t_h} = \frac{\partial^2 \pi^C}{\partial t_h \partial \tau_h} = \frac{\partial^2 \pi^E}{\partial t_h \partial t_l} = \frac{\partial^2 \pi^E}{\partial t_l \partial t_h} = -\frac{1-p}{\delta} g\left(m^A\right) < 0, \\
\frac{\partial^2 \pi^E}{\partial t_h \partial T_h} &= \frac{\partial^2 \pi^C}{\partial t_h \partial T_l} = \frac{\partial^2 \pi^E}{\partial \tau_h \partial t_h} = \frac{\partial^2 \pi^E}{\partial t_h \partial \tau_h} = \frac{\partial^2 \pi^C}{\partial t_h \partial t_l} = \frac{\partial^2 \pi^C}{\partial t_l \partial t_h} = \frac{1-p}{\delta} g\left(m^A\right) > 0, \\
\frac{\partial^2 \pi^C}{\partial \tau_h \partial T_h} &= \frac{1-p}{\delta}\left[g\left(m^A\right) - (1-p)(t_h - \tau_h) g'\left(m^A\right)\right], \\
\frac{\partial^2 \pi^C}{\partial t_l \partial \tau_h} &= \frac{\partial^2 \pi^C}{\partial \tau_h \partial t_l} = \frac{\partial^2 \pi^C}{\partial \tau_h \partial T_l} = -\frac{1-p}{\delta}\left[g(m^A) - (1-p)(t_h - \tau_h) g'(m^A)\right], \\
\frac{\partial^2 \pi^E}{\partial t_l \partial \tau_h} &= \frac{\partial^2 \pi^E}{\partial \tau_h \partial t_l} = \frac{\partial^2 \pi^E}{\partial \tau_h \partial T_l} = \frac{1-p}{\delta}\left[p g(m^A) - (1-p)(t_h - \tau_h) g'(m^A)\right], \\
\frac{\partial^2 \pi^E}{\partial \tau_h \partial T_h} &= -\frac{1-p}{\delta}\left[p g\left(m^A\right) - (1-p)(t_h - \tau_h) g'\left(m^A\right)\right], \\
\frac{\partial^2 \pi^C}{\partial t_l \partial T_h} &= -\frac{\partial^2 \pi^C}{\partial (t_l)^2} = (1-p)^2 S^C g'\left(m^A\right), \\
\frac{\partial^2 \pi^E}{\partial t_l \partial T_h} &= -\frac{\partial^2 \pi^E}{\partial (t_l)^2} = -\frac{(1-p)^2}{\delta}\left[g\left(m^A\right) + (t_h - \tau_h) g'\left(m^A\right)\right], \\
\frac{\partial^2 \pi^C}{\partial t_h^2} &= \frac{\partial^2 \pi^E}{\partial t_h^2} = 0, \\
\frac{\partial^2 \pi^C}{\partial \tau_h^2} &= \frac{1-p}{\delta}\left[2g\left(m^A\right) - (1-p)(t_h - \tau_h) g'\left(m^A\right)\right], \\
\frac{\partial^2 \pi^E}{\partial \tau_h^2} &= -\frac{1-p}{\delta}\left[(1+p) g\left(m^A\right) - (1-p)(t_h - \tau_h) g'\left(m^A\right)\right].
\end{aligned}$$

A.6 Proof of Proposition 1

To prove Proposition 1, we first summarize individuals' optimal decisions in the extreme case when there are no use tax evaders. This means that conditional on shopping abroad, an individual will always decide to declare the imported good and pay the use tax. This will be the case if the size of the expected fine for tax evasion is sufficiently large, i.e.

$$pf > (1-p)(\Gamma_h + \tau_h - T_l - t_l). \tag{A.1}$$

If expected fines are bounded from below, as given by inequality (A.1), no cross-border shopping individual will evade the use tax. This is because their costs of evasion m_i can never be smaller than m^A since by definition $m^A < 0$. As no cross-border shopper will evade the use tax, only the trade-off in (1) applies and only individuals with $S_i \leq S^C$ will opt for a purchase abroad and avoid the sales tax.

Figure A.1 summarizes the consumers' shopping behavior when there are no evaders. Individuals to the left of S^C will always shop across the border. Whether they evade the use tax or not will depend on the level of m^A which is a function of the expected fines. However, because $m^A < 0$, none of the cross-border shopping individuals will evade the use tax, so that in this figure the m^A and m_i^E lines are irrelevant.

Finally, we can calculate the expected number of cross-border shoppers all of whom are compliant with the use tax. This is given by

$$\pi^C = \int_0^{S^C} \int_0^{\bar{m}} g(m_i)\, dm_i \mathrm{d}S_i = S^C. \tag{A.2}$$

Total tax revenues in the large and the small municipality when all individuals are compliant amount to

$$R_h = t_h \left(1 + b - S^C\right) + (\tau_h - t_l) S^C, \tag{A.3}$$

$$R_l = t_l \left(1 - b + S^C\right). \tag{A.4}$$

The first part in (A.3) and (A.4) refers to sales tax revenues from all resident individuals adjusted by cross-border shoppers and the second part in (A.3) is use tax revenues from compliant individuals declaring their cross-border shopping activity. Consumer surplus in the large and the small municipality are respectively given by

$$CS_h = (1 + b)(V - 1 - T_h - t_h) + \frac{(t_h - \tau_h)^2}{2\delta}, \tag{A.5}$$

$$CS_l = (1 - b)(V - 1 - T_l - t_l). \tag{A.6}$$

All consumers in jurisdiction h can at least get a surplus of $V - 1 - T_h - t_h$ if they purchase at home. Cross border shoppers, however, may get additional surplus if $\tau_h < t_h$ because they avoid paying the high sales tax rate t_h but instead pay only the use tax rate τ_h on their cross-border purchase. With this structure in hand, we can now prove the proposition.

Proof. The first-order condition for the use tax

$$\frac{\partial W_h}{\partial \tau_h} = (\lambda - 1)S^C + \lambda \frac{1}{\delta}(t_h - \tau_h + t_l) > 0, \tag{A.7}$$

is positive for all $\tau_h \leq t_h$. An increase in τ_h decreases the number of cross-border shoppers and thus increases sales tax revenues in municipality h. Because gains in sales tax revenues overcompensate both losses in use tax revenues and losses in consumer surplus, an increase in the use tax increases welfare in municipality h. Given that states do not allow use taxes to be greater than the sales tax, at the optimum, municipality h will therefore set its use tax rate at the level of its sales tax rate, that is $\tau_h = t_h$. Consequently, the number of cross-border shoppers will be zero in equilibrium as a compliant individual cannot save any taxes and will only incur wasteful transport costs (we assume $\Gamma_h = T_h$). Knowing that sales tax rates will not affect cross-border shopping, the first-order conditions for the optimal sales tax rate in municipalities h and l simplify to

$$\frac{\partial W_h}{\partial t_h} = (\lambda - 1)(1 + b) > 0, \tag{A.8}$$

$$\frac{\partial W_l}{\partial t_l} = (\lambda - 1)(1 - b) > 0 \tag{A.9}$$

which are both globally positive and the sales tax rate will be set as high as possible in order to extract as much as possible of the surplus from the consumer. □

A.7 Proof of Proposition 2

Proof. Let $p \to 0$. Then all cross-border shopping individuals will evade the use tax, i.e. $\pi^C = 0$, because m^A approaches $\bar{m}$ and consequently $G\left(m^A\right)$ approaches 1. Hence, the first term in equation (10b) approaches zero. Moreover, as shown in Appendix A.5, $\frac{\partial \pi^E}{\partial \tau_h} > 0$ and $\frac{\partial \pi^C}{\partial \tau_h} = -\frac{\partial \pi^E}{\partial \tau_h}$. As $t_h - p(\tau_h - t_l) > t_h - \tau_h + t_l$, the term in square brackets in equation (10b) is positive, ultimately leading to a negative first-order condition for τ_h and hence $\tau_h = t_l$. Setting $\tau_h = t_l$ is a weakly dominant strategy as a further decrease will not increase welfare of municipality h. Moreover, evaluating the first-order conditions for the optimal sales tax rate at $t_h = \tau_h$ using that $p \to 0$ and hence $t_h = \tau_h = t_l$ yields

$$\frac{\partial W_h}{\partial t_h} = (\lambda - 1)\left(1 + b - \pi^E\right) - \lambda t_l \frac{1}{\delta}. \tag{A.10}$$

Hence, a sufficient condition for the first-order condition A.10 to be positive at $t_h = \tau_h$ and thus for $t_h > \tau_h$ in equilibrium is that b is sufficiently large. This is because a sufficiently large b not only implies a large sales tax base in municipality h and thus a large first term in equation A.10 but also a low sales tax base in municipality l and thus a low level of t_l in equilibrium which implies a small second term in eq. A.10. Hence, if b is sufficiently large, we get in equilibrium $t_h > \tau_h$, so that the local sales and use tax rates will differ if p is sufficiently low. Because $\tau_h = t_h$ if expected fines are sufficiently large (see analysis in the previous subsection) there must be a critical probability of detection $\bar{p}$ below which the use tax rate is set below the sales tax rate. $\square$

A.8 Proof of Proposition 3

To analytically determine the comparative-static effects of changes in T_h on the simultaneous choice of the local sales and use tax rate, and in turn the difference Δ, we totally differentiate the first-order conditions for t_h, τ_h and t_l given in equations (10a)-(10c). We use the following general system of equations to prove Proposition 3:

$$\begin{bmatrix} \alpha_1 & \alpha_2 & \alpha_3 \\ \alpha_4 & \alpha_5 & \alpha_6 \\ \alpha_7 & \alpha_8 & \alpha_9 \end{bmatrix} \times \begin{bmatrix} dt_h \\ d\tau_h \\ dt_l \end{bmatrix} = \begin{bmatrix} -\alpha_{10} \\ -\alpha_{11} \\ -\alpha_{12} \end{bmatrix} dT_h + \begin{bmatrix} -\alpha_{13} \\ -\alpha_{14} \\ -\alpha_{15} \end{bmatrix} dT_l, \tag{A.11}$$

where

$$\alpha_1 = \frac{\partial^2 W_h}{\partial (t_h)^2},\ \alpha_2 = \frac{\partial^2 W_h}{\partial t_h \partial \tau_h},\ \alpha_3 = \frac{\partial^2 W_h}{\partial t_h \partial t_l},\ \alpha_4 = \frac{\partial^2 W_h}{\partial \tau_h \partial t_h},\ \alpha_5 = \frac{\partial^2 W_h}{\partial (\tau_h)^2},\ \alpha_6 = \frac{\partial^2 W_h}{\partial \tau_h \partial t_l}$$
$$\alpha_7 = \frac{\partial^2 W_l}{\partial t_l \partial t_h},\ \alpha_8 = \frac{\partial^2 W_l}{\partial t_l \partial \tau_h},\ \alpha_9 = \frac{\partial^2 W_l}{\partial (t_l)^2},\ \alpha_{10} = \frac{\partial^2 W_h}{\partial t_h \partial T_h},\ \alpha_{11} = \frac{\partial^2 W_h}{\partial \tau_h \partial T_h},\ \alpha_{12} = \frac{\partial^2 W_l}{\partial t_l \partial T_h},$$
$$\alpha_{13} = \frac{\partial^2 W_h}{\partial t_h \partial T_l},\ \alpha_{14} = \frac{\partial^2 W_h}{\partial \tau_h \partial T_l},\ \alpha_{15} = \frac{\partial^2 W_l}{\partial t_l \partial T_l}.$$

Proof. We start the proof of Proposition 3 by differentiating between municipalities with and without a ban on local use tax rates. When analyzing the effect of T_i on municipality j's difference in local commodity tax rates Δ in the ban case, the system of equations in (A.11) simplifies to

$$\begin{bmatrix} \alpha_1 & \alpha_3 \\ \alpha_7 & \alpha_9 \end{bmatrix} \times \begin{bmatrix} dt_h \\ dt_l \end{bmatrix} = \begin{bmatrix} -\alpha_{10} \\ -\alpha_{12} \end{bmatrix} dT_h + \begin{bmatrix} -\alpha_{13} \\ -\alpha_{15} \end{bmatrix} dT_l, \tag{A.12}$$

where

$$\begin{aligned}
\alpha_1 &= -\frac{1}{\delta}(2\lambda-1)<0,\\
\alpha_3 &= \frac{1-p}{\delta}\left[(\lambda-1)\,G\left(m^A\right)+\lambda(1-p)(\tau_h-t_l)\,g\left(m^A\right)\right]>0,\\
\alpha_7 &= \frac{1}{\delta}\lambda>0,\\
\alpha_9 &= -\lambda\frac{1-p}{\delta}\left[2G\left(m^A\right)-t_l(1-p)g\left(m^A\right)\right]<0,\\
\alpha_{10} &= -\frac{1-p}{\delta}\left[(\lambda-1)\,G\left(m^A\right)+\lambda(1-p)(\tau_h-t_l)\,g\left(m^A\right)\right]=-\alpha_3<0,\\
\alpha_{12} &= \lambda\frac{1-p}{\delta}\left[G\left(m^A\right)-t_l(1-p)\,g\left(m^A\right)\right]\\
\alpha_{13} &= \frac{(1-p)}{\delta}\left[(\lambda-1)\,G\left(m^A\right)+\lambda(1-p)(\tau_h-t_l)\,g\left(m^A\right)\right]=\alpha_3>0,\\
\alpha_{15} &= -\lambda\frac{1-p}{\delta}\left[G\left(m^A\right)-t_l(1-p)\,g\left(m^A\right)\right]=-\alpha_{12.}
\end{aligned}$$

Applying Cramer's rule to the system delivers

$$\begin{aligned}
\frac{d\Delta_h}{dT_h} &= \frac{dt_h}{dT_h}=\frac{\alpha_3\alpha_{12}+\alpha_3\alpha_9}{|\hat{A}|},\\
\frac{d\Delta_l}{dT_h} &= \frac{dt_l}{dT_h}=-\frac{\alpha_3\alpha_7+\alpha_1\alpha_{12}}{|\hat{A}|},\\
\frac{d\Delta_h}{dT_l} &= \frac{dt_h}{dT_l}=-\frac{\alpha_3\alpha_{12}+\alpha_3\alpha_9}{|\hat{A}|},\\
\frac{d\Delta_l}{dT_l} &= \frac{dt_l}{dT_l}=\frac{\alpha_3\alpha_7+\alpha_1\alpha_{12}}{|\hat{A}|},
\end{aligned} \tag{A.13}$$

where $|\hat{A}|=\alpha_1\alpha_9-\alpha_3\alpha_7>0$ to obtain a maximum. Plugging the α-terms into (A.13) yields

$$\begin{aligned}
\frac{d\Delta_h}{dT_h} &= -\frac{d\Delta_h}{dT_l}=-\frac{\alpha_3\lambda\frac{1-p}{\delta}G\left(m^A\right)}{|\hat{A}|}<0,\\
\frac{d\Delta_l}{dT_h} &= -\frac{d\Delta_l}{dT_l}=\lambda\frac{1-p}{\delta^2}\frac{\lambda G\left(m^A\right)-\left[(\lambda-1)\,t_l+\lambda\tau_h\right](1-p)\,g\left(m^A\right)}{|\hat{A}|}.
\end{aligned}$$

In principle, the sign of $\frac{d\Delta_l}{dT_h}$ is ambiguous. However, if p is low, $G\left(m^A\right)\to 1$ and $\tau_h\to t_l$. Because $(2\lambda-1)\,t_l$ reaches the largest value relative to λ if $\lambda\to\infty$ and $t_l\to 1$, a sufficient condition for $\frac{d\Delta_l}{dT_h}$ to be larger than zero is $g(\bar{m})<\frac{1}{2}$. Even if we allow p to be substantially larger than zero, $\frac{d\Delta_l}{dT_h}$ is greater than zero under the sufficient condition that λ is not too large. At $\lambda=1$, it is straightforward to see that $\frac{d\Delta_l}{dT_h}>0$. Hence, an increase in T_h-T_l decreases [increases] Δ_i in high-tax [low-tax] border-municipalities with a ban.

When analyzing the effects of T_i on Δ_h in municipalities without a ban, we need to take τ_h into account, but condition on the fact that t_h and τ_h differ, i.e. we analyze the change in Δ for $p \to 0$. To determine the sign of $\frac{d\Delta_i}{dT_j}$, $i, j = \{h, l\}$, we use

$$
\begin{aligned}
\alpha_1 &= -\frac{1}{\delta}(2\lambda - 1) < 0, \\
\alpha_2 &= 0, \\
\alpha_3 &= \frac{1}{\delta}(\lambda - 1) > 0, \\
\alpha_4 &= 0 \\
\alpha_5 &= -\left[(2\lambda - 1)(t_h - \tau_h) + \lambda t_h\right] \frac{g(\bar{m})}{\delta} < 0, \\
\alpha_6 &= \left[(\lambda - 1)(t_h - \tau_h) + \lambda t_h\right] \frac{g(\bar{m})}{\delta} > 0, \\
\alpha_7 &= \lambda \frac{1}{\delta} > 0, \\
\alpha_8 &= -\lambda \frac{1}{\delta} t_l g(\bar{m}) < 0, \\
\alpha_9 &= -\lambda \frac{1}{\delta}\left[2 - t_l g(\bar{m})\right] = -(2\alpha_7 + \alpha_8) < 0, \\
\alpha_{10} &= -\frac{1}{\delta}(\lambda - 1) = -\alpha_3 < 0, \\
\alpha_{11} &= -\left[(\lambda - 1)(t_h - \tau_h) + \lambda t_h\right] \frac{g(\bar{m})}{\delta} = -\alpha_6 < 0, \\
\alpha_{12} &= \lambda \frac{1}{\delta}\left[1 - t_l g(\bar{m})\right] = \alpha_7 + \alpha_8 > 0, \\
\alpha_{13} &= \alpha_3 > 0, \\
\alpha_{14} &= \left[(\lambda - 1)(t_h - \tau_h) + \lambda t_h\right] \frac{g(\bar{m})}{\delta} = \alpha_6 > 0, \\
\alpha_{15} &= -\alpha_{12.} < 0.
\end{aligned}
$$

which simplifies the matrix to

$$
\begin{bmatrix} \alpha_1 & 0 & \alpha_3 \\ 0 & \alpha_5 & \alpha_6 \\ \alpha_7 & \alpha_8 & -(2\alpha_7 + \alpha_8) \end{bmatrix} \times \begin{bmatrix} dt_h \\ d\tau_h \\ dt_l \end{bmatrix} = \begin{bmatrix} \alpha_3 \\ \alpha_6 \\ -(\alpha_7 + \alpha_8) \end{bmatrix} dT_h + \begin{bmatrix} -\alpha_3 \\ -\alpha_6 \\ (\alpha_7 + \alpha_8) \end{bmatrix} dT_l. \tag{A.14}
$$

Applying Cramer's rule delivers

$$
\begin{aligned}
\frac{dt_h}{dT_h} &= -\frac{\alpha_3\alpha_5\alpha_7}{|A|} < 0, \\
\frac{d\tau_h}{dT_h} &= -\frac{\alpha_1\alpha_6\alpha_7}{|A|} < 0, \\
\frac{d\Delta_l}{dT_h} = \frac{dt_l}{dT_h} &= \frac{\alpha_5(\alpha_7\alpha_7 - \alpha_1\alpha_8) - \alpha_1\alpha_6\alpha_8}{|A|},
\end{aligned}
$$

where $|A| = \alpha_1\alpha_5\alpha_9 - \alpha_3\alpha_5\alpha_7 - \alpha_1\alpha_6\alpha_8 < 0$ to obtain a maximum. A sufficient condition for $\alpha_7\alpha_7 - \alpha_1\alpha_8 > 0$ and hence $\frac{d\Delta_l}{dT_h} > 0$ is that $g(\bar{m}) < \frac{1}{2}$. The effect of T_h on Δ_h is then given by

$$\frac{d\Delta_h}{dT_h} = \frac{dt_h}{dT_h} - \frac{d\tau_h}{dT_h} = -\frac{(\alpha_3\alpha_5 - \alpha_1\alpha_6)\,\alpha_7}{|A|} = -\frac{\frac{1}{\delta}\lambda^2 t_h g(\bar{m})\,\alpha_7}{|A|} > 0.$$

Moreover, because the effects of a change in T_l are quantitatively identical with the only difference being the sign, an increase in $T_h - T_l$ increases the local sales and use tax rate differential Δ in high-tax as well as low-tax municipalities without a ban.

□

A.9 Proof of Proposition 4

In the following, we will analyze, how a change in state i's sales tax rate T_i will affect the difference in local commodity tax rates Δ_i in ban and no-ban municipalities if consumers only purchase online. The departure of our analysis is the first-order conditions of the high-tax municipality, given in (10a) and (10b), since online shopping is the only alternative to a purchase at home. The reason is that every municipality is high-tax relative to the internet where sales taxation is zero-rated which implies that online shopping is qualitatively equivalent to out-of-state cross-border shopping.

Proof. Starting with the ban case, in which τ_i cannot be affected by the municipality, the effect of an increase in T_i is given by

$$\frac{d\Delta_i}{dT_i} = \frac{dt_i}{dT_i} = -\frac{\alpha_{10}}{\alpha_1} < 0,$$

which implies that the local tax differential decreases upon an increase in T_i. Turning to municipalities without a ban, the effect of a change in T_i becomes

$$\frac{d\Delta_i}{dT_i} = \frac{dt_i}{dT_i} - \frac{d\tau_i}{dT_i} = \frac{\alpha_1\alpha_{11} - \alpha_5\alpha_{10}}{|B|} = \frac{\frac{1}{\delta^2}\left[(\lambda-1)^2\tau_h + (2\lambda-1)\,t_h\right] g(\bar{m})}{|B|} > 0,$$

where $|B| = \alpha_1\alpha_5 > 0$, because $\alpha_2 = \alpha_4 = 0$ when $p \to 0$. □

A.10 Additional results

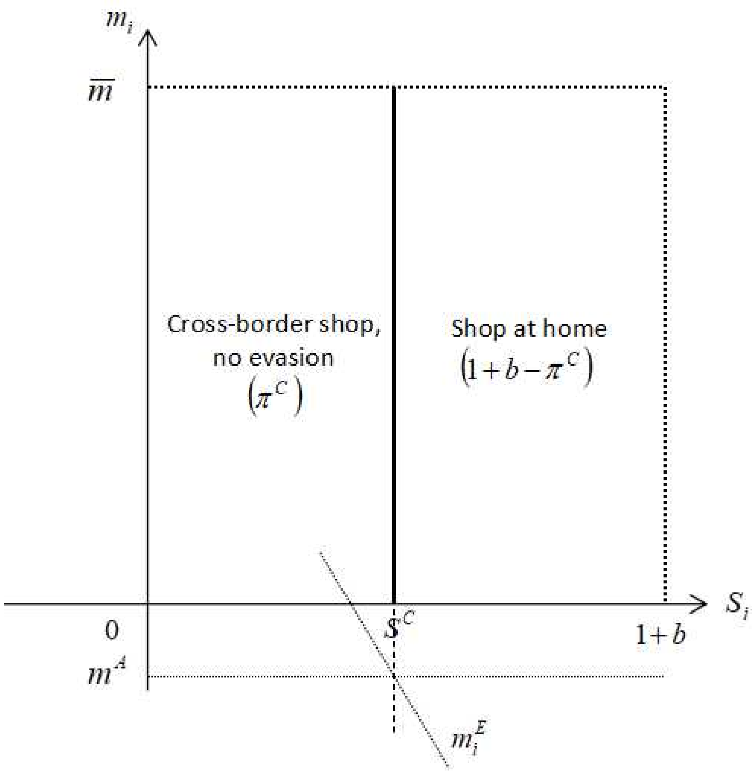
A.10.1 Definition of H

As a robustness check, we use an alternative definition for H, where we define towns as being on the high-tax and low-tax side of the border using state tax rate data that precedes our sample used in the analysis. We then keep this definition over the entire course of our sample and check how towns respond. These results are only relevant for ban states because towns in no ban states do not have any borders that change this status. Compared to column (1) of Table 4, we estimate effects of -0.588*** and 0.666***.

A.10.2 Effect on sales and use taxes

Now, we focus on describing the results in Table A.2 for states *without* use tax bans. Recall in these states, for towns on the high-tax side, the model predicts that both sales and use tax rates should decline when the state tax differential increases. However, the model predicts the decline in use taxes should be much larger than the sales tax. To test this, we estimate our model with sales and use taxes as separate dependent variables. We find effects on the sales and use tax that are generally consistent with the model, but often statistically insignificant. However, these regressions should be interpreted with caution. If the sales and use tax rate are simultaneously determined, the regressions suffer from omitting the other tax rate. Thus, these results should be viewed as only descriptive. For this reason, we prefer regressions using Δ as the dependent variable because we need not control for the level of the other tax rate.

Figure A.1: Shopping behavior: no evading individuals



All variables are defined in Table 3.

Table A.1: Survey of states regarding use taxes as of current law

	State Sales and Use Tax?	Local Sales Tax?	Local Use Tax Allowed?	Local Choice on Both Rates?
Alabama	Yes	Yes	Yes	Yes
Alaska	No	Yes	Yes	Yes
Arizona	Yes	Yes	Yes	Yes
Arkansas	Yes	Yes	Yes	No
California	Yes	Yes	Yes	No
Colorado	Yes	Yes	Yes	Yes
Connecticut	Yes	No	-	-
Delaware	No	No	-	-
D.C.	Yes	No	-	-
Florida	Yes	Yes	Yes	No
Georgia	Yes	Yes	Yes	No
Hawaii	Yes	Yes	Yes	No
Idahoˆ	Yes	Yes	No	No
Illinois	Yes	Yes	No	No
Indiana	Yes	No	-	-
Iowa	Yes	Yes	No	No
Kansas	Yes	Yes	Yes	No
Kentucky	Yes	No	-	-
Louisiana	Yes	Yes	Yes	No
Maine	Yes	No	-	-
Maryland	Yes	No	-	-
Massachusetts	Yes	No	-	-
Michigan	Yes	No	-	-
Minnesota	Yes	Yes	Yes	No
Mississippi	Yes	Yes	No	No
Missouri	Yes	Yes	Yes	Yes
Montana	No	No	-	-
Nebraska	Yes	Yes	Yes	No
Nevada	Yes	Yes	Yes	No
New Hampshire	No	No	-	-
New Jersey	Yes	No	-	-
New Mexico	Yes	Yes	No	No
New York	Yes	Yes	Yes	No
North Carolina	Yes	Yes	Yes	No
North Dakota	Yes	Yes	Yes	No
Ohio	Yes	Yes	Yes	No
Oklahoma	Yes	Yes	Yes	Yes
Oregon	Yes	No	-	-
Pennsylvaniaˆ	Yes	Yes	Yes	No
Rhode Island	Yes	No	-	-
South Carolina	Yes	Yes	Yes	No
South Dakota	Yes	Yes	Yes	No
Tennessee	Yes	Yes	Yes	No
Texas	Yes	Yes	Yes	No
Utah	Yes	Yes	Yes	No
Vermontˆ	Yes	Yes	No	No
Virginia	Yes	Yes	Yes	No
Washington	Yes	Yes	Yes	No
West Virginia	Yes	Yes	Yes	No
Wisconsinˆ	Yes	Yes	Yes	No
Wyoming	Yes	Yes	Yes	No

The answers to these questions come from our survey of state governments and were obtained through phone or email interviews with state officials. In cases where no state officials responded, we used online resources to best obtain the answers. Some state classifications require explanations and these states are marked with ˆ. These states have further details and discussion in the appendix text.

Table A.2: Effect of state tax differential shock on local sales and use tax rates separately

Use Tax Policy	Side of Border	Theory	Local Sales Tax (1)	(2)	Theory	Local Use Tax (1')	(2')
Ban Use Taxes, Differential ($\Lambda_{i,t}$)	High-Tax	< 0	-0.585***	-0.589***	n/a	n/a	n/a
			(0.104)	(0.082)			
	Low-Tax	> 0	0.735***	0.665***	n/a	n/a	n/a
			(0.068)	(0.120)			
Ban Use Taxes, Own-state Rate ($T_{i,t}$)	High-Tax and Low-Tax	< 0	-0.924***	-0.892***	n/a	n/a	n/a
			(0.077)	(0.088)			
Allow Use Taxes, Differential ($\Lambda_{i,t}$)	High-Tax	< 0	-0.211	-0.081	$\ll 0$	-0.315	-0.210
			(0.147)	(0.171)		(0.221)	(0.324)
	Low-Tax	> 0	-0.034*	-0.050**	0	0.007	0.008
			(0.172)	(0.020)		(0.020)	(0.024)
Allow Use Taxes, Own-state Rate ($T_{i,t}$)	High-Tax and Low-Tax	< 0	0.112	-0.002	$\ll 0$	-0.517	-0.409
			(0.167)	(0.121)		(0.368)	(0.327)
		Time FE?	Y	Y		Y	Y
		Town FE?	Y	Y		Y	Y
		Controls?	Y	Y		Y	Y

Each *cell* represents a separate regression estimating (16) split by state use tax policy status and high/low-tax side of the border. The theoretically expected signs of each subsample are given in the table and are derived in appendix (A.8); for changes in $\Lambda_{i,t}$, the theoretically expected signs assume only cross-border shopping while for changes in $T_{i,t}$, only online shopping is assumed. The dependent variable is the local sales tax rate in columns without a prime and is the local use tax rate in columns with a prime. All models are estimated using data from December of each year from 2003 to 2011. The model contains time fixed effects and town fixed effects and local controls, state-level controls, and neighboring state level controls. A time lagged dependent variable is included and appropriately instrumented for. In the first two rows of each section, the independent variable of interest is the state sales tax rate differential defined as the absolute value of the state tax rate minus the nearest neighboring state sales tax rate; in the last rows of each panel it is the own-state tax rate. We instrument for these variables as in the text. Column (1) estimates the baseline specification. Column (2) drops small towns with populations below 500. All standard errors in ( ) are clustered at the county level to account for local tax competition. ***99%, **95%, and *90%.