The Internet as a Tax Haven?: The Effect of the Internet on Tax Competition

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Abstract

Firms with a physical presence in a consumer's state are required to collect state and local sales taxes on online sales; sales from remote vendors without a physical presence are not subject to sales tax collection. Theoretically, a large fraction of shoppers with Internet access will put downward pressure on tax rates as jurisdictions seek to reduce revenue leakage to a tax-free source; but, taxable online sales will put upward pressure on tax rates because the Internet acts as an effective means of enforcing sales tax collections. I use novel data – all municipal and county sales tax rates in the country and Internet penetration rates at the municipal level from 2011 – to test the theory. I show that having more residents with access to the Internet has little effect on tax rates in very small jurisdictions that have relatively few brick-and-mortar stores, but puts downward pressure on tax rates in larger jurisdictions. Intuitively, this heterogeneity arises because large municipalities are likely to have relatively more e-commerce on tax-free websites as a result of taxable online vendors already having a physical presence nearby. Exploiting tax discontinuities at state borders, I find that that an increase in the Internet penetration rate induces municipalities on the low-tax side of state borders to lower their local tax rates by more than municipalities on the high-tax side; this result is consistent with towns on the high-tax side having less brick-and-mortar stores and more consumers with easy non-Internet means of tax avoidance. The results are robust to instrumenting for Internet penetration rates with the average flash density of lightning in each county.

JEL: H25, H71, H73, L81, R50

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1 Introduction

This paper will study the tax setting behavior of jurisdictions in the modern "new economy." Does the Internet cause cities and towns to raise or lower their sales tax rates? On the one hand, if online transactions are untaxed, the Internet may act as a tax haven and put downward pressure on local tax rates. On the other hand, if e-commerce is taxed, the Internet may act as an anti-haven, allowing cities and towns to collect taxes on remote transactions that previously went untaxed. The possibility that the Internet may act as an anti-haven in a world of increased competition is important for policymaking (i.e., the Marketplace Fairness Act of 2013) and is an over-looked possibility.

The Marketplace Fairness Act of 2013 was recently introduced in Congress, which if passed, will allow states to require most firms – including online vendors – to collect state and local sales taxes. Current law requires only firms with nexus within a state to collect the retail sales tax; a firm only has nexus in a state if it has a physical presence in the state from which it profits. As a result, many online firms such as eBay and Amazon.com, do not collect retail sales taxes in most states. Some policymakers have argued that this practice gives online firms a competitive advantage at selling commodities by being able to charge lower after-tax prices in comparison to brick-and-mortar stores. In 2011, consumers spent approximately 200 billion dollars (5% of all retail sales) on online purchases. Of these purchases, approximately, 11% occurred on eBay and approximately 13-19% occurred on Amazon (Einav et al. 2013). For many users of Amazon and eBay, these transactions were tax free.

Existing studies indicate that individuals are sensitive to after-tax price differences resulting from the tax-free sale of online goods. Given that the elasticity of demand is an important determinant of tax rates in a competitive game between jurisdictions, tax rates will be sensitive to the responsiveness of individuals to tax-free Internet shopping. However, economists have not studied how the presence of a tax-free Internet influences the competitive tax setting behavior (tax competition) of state and local governments.

Tax competition is a game whereby governments compete with each other in order to attract a mobile tax base – in the case of sales taxes, the mobile tax base is composed of consumers who have choice on where they want to purchase a good. Traditional studies of tax competition focus on how the tax base is mobile between different players (governments) of the game. But, what happens if the tax base is like a "leaky bucket" and some shoppers can go to a "jurisdiction" that is not a participant in the game, for example the Internet? Because rules governing taxation of the Internet must originate from the federal government, individual municipalities competing for shoppers have little control over how Internet sales are taxed other than to try to lure online firms to establish a physical presence in their state or to encourage the state to broaden the definition of nexus. At the same time that the tax base is a leaky bucket, can the Internet also expand the tax base for local jurisdictions and how does this effect influence tax setting behavior?

I highlight the two roles of the Internet in the current regime: (1) the Internet creates a leaky bucket where jurisdictions see declines in tax revenue as a result of online vendors without nexus and (2) the Internet allows local jurisdictions to effectively enforce the sales tax on the basis of the consumer's location for online transactions originating from firms with nexus. The first effect suggests that the Internet may have similar effects on tax competition as tax havens and will result in inefficiently low tax rates. Tax havens can intensify tax competition and are thus responsible for revenue and welfare losses (Slemrod and Wilson 2009).[1] Although corporate income tax havens have the authority to determine their own tax rate and the Internet does not, understanding the effect of the Internet is useful to understanding the welfare and revenue losses from tax havens and tax evasion more generally. The second point regarding the Internet as a means of tax enforcement is often ignored when thinking about online sales. Firms such as Amazon.com and eBay.com represent only a fraction of online sales. Many other online transactions occur on sites such as Walmart.com and Lowes.com – for which these firms have nexus within most every state in the United States. Current laws of nexus require that once a firm has nexus within one locality in a state, it must collect sales taxes on online purchases for every municipality in the state. Thus, for many towns with no retail sales stores within the town, the presence of Walmart.com and Lowes.com in their state actually allows for the local jurisdictions with no firms of its own to collect some taxes. This lowers the marginal cost of raising tax rates on sales as the jurisdiction can now collect taxes from online purchases. As the marginal cost of collecting revenue from sales taxes falls, the tax rate will rise as jurisdictions shift away from other tax instruments. More generally, some consumers who would have engaged in cross-border shopping now buy taxable goods online, which reduces the competitive pressure between jurisdictions and raises tax rates.

Thus, these two offsetting effects make the effect of the Internet on tax rates an empirical question: the pressures from having a tax "haven" for online shopping must be traded off with the fact that the Internet helps jurisdictions easily and effectively collect taxes from remote firms with nexus. Because I can determine which of these two effects dominates, understanding the pressures arising from taxable online sales versus tax-free online transactions will shed light on how tax competition affects the current regime as well as how the Marketplace Fairness Act of 2013 – which makes online transactions taxable – would affect

[1] Hines (2010) describes the effects of tax havens more generally.

tax competition.

One novelty of this paper lies in the data sources that I combine in order to derive robust measures of the effect of the Internet on local sales tax rates. I have data on 2011 municipal tax rates and 2011 broadband penetration data for all towns in the country. The tax data are a complete cross-section of all municipal tax rates in the country – at the county, state, municipal, and sub-municipal level. The data includes approximately 15,000 towns and over 2000 counties that are in states that allow for local sales tax rates. To this data I merge broadband penetration rates at the Census place and county level. The data on broadband penetration includes measures regarding the quality of the Internet service, whether the service is wireline or wireless, and the fraction of individuals with access to an Internet service provider and the fraction of individuals with access to more than one Internet provider. While broadband penetration is not a perfect measure of usage of the Internet, which may be a function of factors such as income, I demonstrate using the Current Population Survey (CPS) Computer and Internet Usage Supplement that the penetration data is a good proxy for Internet access and use.

To preview the results, the paper motivates the empirical question through a theoretical model. The model modifies the Nielsen (2001)-Agrawal (2012) model of tax competition by introducing revenue leakages to the Internet and by allowing for taxable e-commerce. Consider the case of two jurisdictions with uniform population and size, but where one town is the border-town in a high-tax state and the other town is a border town in a low-tax state. If the Internet is tax-free, then an increase in access to the Internet in both jurisdictions will lower local tax rates in both jurisdictions. Critically, local taxes will fall in the low-tax state by more than in the high-tax state because the revenue lost to online sales will be lower for towns in the high-tax state given these towns set low tax rates without e-commerce. This result intuitively arises because, even without a tax-free Internet, border towns in high-tax states are already constrained by fear of cross-border shopping when setting their local tax rates relative to towns in low-tax states. The asymmetry of the effect of the Internet naturally yields a border design to empirically test for the effect of the Internet on tax rates. The model then shows that if the Internet is not tax-free and if some consumers have a preference to shop online (added product variety, convenience, etc.), the presence of more Internet shoppers will place upward pressure on tax rates as some shoppers who previously cross-border shop, now purchase taxable goods.

The paper then tests the theoretical predictions empirically using a fractional response model within a border discontinuity design. This is the first paper to use a fractional response model to study tax setting behavior – a fractional response allows for the fact that tax rates are constrained to be between zero and one. The paper emphasizes the effect of the Internet on the strategic interaction of governments given that we know the Internet induces large changes in consumer behavior (Goolsbee, Lovenheim and Slemrod 2010). I demonstrate that for very small jurisdictions, the marginal effect of additional Internet users as a small effect local sales tax rates. The anti-haven effect is likely stronger in small jurisdictions that are unlikely to have any brick-and-mortar stores within the jurisdiction by lowering the cost of tax collection from sales relative to other tax instruments. However, for large jurisdictions, an increase in Internet penetration has negative effects on local tax rates as these jurisdictions seek to reduce the revenue leakage to an outside source.

The results indicate that going from no Internet access to complete access lowers local sales taxes by between .05 and .15 percentage points, which is about 6% to 20% of the average municipal rate in 2011. Acknowledging that Internet penetration may be spatially correlated and omitted variables, I exploit a border-based approach where I test the theoretical prediction that the responses to Internet penetration levels are asymmetric on the high-tax and low-tax side of the border.[2] Internet penetration places strong downward pressure on local tax rates on the low-tax sides of borders; the effect is muted on the high-tax side of the border where municipal jurisdictions are already forced to lower their tax rates in order to reduce cross-border shopping. In many specifications, Internet penetration has no effect on the high-tax sides of borders, except in very high-tax states. For towns extremely close to the state border, tax haven pressures from online shopping are again largest in big jurisdictions. These heterogeneous results, combined with the asymmetric predictions from theory, convincingly demonstrate that the effect of the Internet is driven by its impact on tax competition. The results are also robust to two robustness checks. Using the Lubotsky and Wittenberg (2006) procedure for multiple proxy variables will yield even larger results in absolute value by muting measurement error issues. Instrumenting for Internet penetration with lightning flash density as suggested in Andersen et al. (2012) also increases the results in absolute value.

The results in this paper suggest that many towns perceive the Internet as a tax haven; this story is consistent with news headlines featuring politicians asking Congress to pass legislation to allow for tax collection on all e-commerce. If the federal government passes the Marketplace Fairness Act, the results in this paper suggest that municipalities may respond by increasing their tax rates as they would no longer be constrained by the tax haven effects discussed below.

[2]Border-based approaches were first used in Holmes (1998) and have been modified to study tax avoidance by Lovenheim (2008), Merriman (2010), and Engel et al. (2013). For a more general discussion of tax discontinuities as a means of identification, see Kleven and Waseem (2013).

2 Literature and Background

2.1 Tax Competition

The theoretical literature on sales tax competition (Mintz and Tulkens 1986; Kanbur and Keen 1993; Trandel 1994; Haufler 1996; Nielsen 2001) has focused on how asymmetries across jurisdictions influence tax setting behavior. The general finding within this literature is that larger jurisdictions set higher tax rates than smaller jurisdictions and jurisdictions with a higher preference for public goods will set higher tax rates, all else equal. Revenue maximization is a common assumption, but some studies consider other objectives (Wildasin 1988; Haufler 1996). In contrast to these competitive studies, Hoyt (2001) focuses on the optimal tax setting behavior of jurisdictions within a federation. The elasticity of demand is a fundamental component of these models; jurisdictions that perceive high elasticities set lower tax rates.

Other studies of tax competition have focused on empirically estimating the strategic reaction functions of governments with respect to neighboring jurisdictions. These empirical studies on the taxation of commodities (Besley and Rosen 1998; Devereux, Lockwood and Redoano 2007) and often regress a jurisdiction's tax rate on a weighted average of its neighbor's tax rates after appropriately instrumenting and accounting for federal relationships. The study of local sales taxes in a competitive environment has been studied on a state by state basis in (Luna 2003; Sjoquist et al. 2007; Burge and Piper 2012) due to data limitations. However, Agrawal (2012) and Agrawal (2013) study tax competition using a national cross-section of local sales tax rates from an earlier cross-section of data than will be utilized in this study.

2.2 The Effect of the Internet

Recent studies on the effect of the Internet have focused on two aspects – the effect of the Internet on taxable sales and the effect of the Internet on tax revenue. No studies have analyzed the effect of the Internet on tax rates or on the competitive game of setting tax rates.[3]

Goolsbee (2000) studies the effect of local sales taxes on whether individuals buy online or not and finds big effects in high-tax localities. Ballard and Lee (2007) studies the probability of shopping on the Internet and finds that it is highest in high-tax counties and that consumers who live adjacent to counties with low taxes are less likely to shop on the Internet.

[3]Bruce, Fox and Murray (2003) focuses on the taxation of Internet sales in the context of an optimal tax exercise. Fox and Murray (1997) and Goolsbee and Zittrain (1999) provide a broad discussion of sales taxes and electronic commerce.

Goolsbee, Lovenheim and Slemrod (2010) merges data on Internet access from the CPS and smoking rates (by state) and show that there has been substantial increase in the sensitivity of taxable cigarette sales. Einav et al. (2013) finds that a 1 percentage point increase in sales tax rates reduces purchases on eBay from sellers that are in-state by 4% as individuals substitute to out of state sellers.

With regard to the revenue consequences, Bruce and Fox (2000) and Bruce, Fox and Luna (2009) find that the Internet induces large revenue leakages for states. This contrasts with studies using a random sample of eBay electronics (Alm and Melnik 2010; Alm and Melnik 2012) which indicates the use tax leakage from the Internet is slightly smaller (less than 2% of revenue) and that the compliance rates are low.

The evidence indicates that the consumer response to the presence of a tax free Internet is large. Taking the theoretical models of tax competition to heart – which indicate that the elasticity of demand inversely pins down the pattern of tax rates – studies of the effect of the Internet on consumption suggest that jurisdictions with high Internet access will have large swings in their elasticities, which should then feedback into tax rates.

2.3 Local Sales Taxes and Nexus

The United States system of commodity taxation is highly decentralized. Sales taxes are levied at the state, county, municipal and sub-municipal level. Forty-six states have non-zero sales tax rates and of these states, over thirty states allow for some sort of local taxation within the state. Within states that allow municipalities to set local sales tax rates, the statutory local rates add anywhere between zero percentage points to 6 percentage points on top of the state sales tax rate. Sales taxes contribute anywhere between 1% and 50% of municipal revenue, with the average being approximately 10%.

The autonomy in assessing local sales tax rates varies by state. Approximately five states give their municipalities and counties both free rein to set any local tax rate that they wish. Other states restrict the abilities of local tax setting behavior in some manner. For example, some states delegate local tax setting behavior to either municipalities only or counties only. Other states require all counties to set a minimum local sales tax rate. Still other states set the increments by which municipalities can increase their rates or cap the maximum rate at a given percentage point. However, even in most of these states, the autonomy of the locality remains to determine their sales tax rate within the confines of the rules established by the state.

Commodities in the United States are taxed using two separate but highly-related taxes – the sales and use taxes. Consumers of goods are required to pay use taxes on any goods purchased in neighboring jurisdictions or from online vendors not required to collect sales taxes. The use tax is often levied at the same rate as the sales tax and consumers can declare a credit for any sales taxes paid to other states or jurisdictions. The use tax is notoriously under-enforced and as a result, consumers are (*de facto*) taxed on the basis of the origin of the sale. Because the use tax is under-enforced, consumers are able to avoid (or evade) their tax liability from online purchases from firms without nexus.

Given this system, the reader may wonder why states do not require all remote remote vendors to collect and remit the sales tax. Based on the Supreme Court of the United States ruling *Quill Corp. v. North Dakota*, online firms are only required to collect sales taxes from consumers living in a state where the firm has nexus. Nexus means the company must have a physical presence in the state from which it profits. This creates two types of online firms – those required to remit sales taxes (Walmart.com) and those not required to remit sales taxes (Amazon.com in most states). Why did the court rule this way? Requiring these companies to collect the sales tax would cause remote vendors undue harm, which could infringe on cross-state trade. These additional costs may seem trivial for large online vendors but for small out-of-state vendors, the costs of complying with fifty state sales tax policies and more than 8000 local sales tax policies could be sufficiently costly. The Court ruling was held under the Dormant Commerce Clause, which allowed the Court to explicitly state that if the federal government passes a law requiring online vendors to collect sales taxes, then such collection would be Constitutional. It is on this basis that the Marketplace Fairness Act of 2013 would be able to require remote vendors to collect sales taxes.

3 Model

In this section, I will modify the Nielsen (2001)-Agrawal (2012) model of tax competition between two towns located in different states; the modification will allow for online shopping. When making this modification, Internet access will have a upward or downward pressure on the Nash equilibrium. The purpose of this section is not to develop a stand-alone model of online shopping, but rather to show that the effect of e-commerce will be asymmetric depending on whether a jurisdiction is located in a high- or low-tax state.

The model features two towns that are both one unit long and with population density of unity. Each town indexed $i = H, L$ is located in a different state; states exogenously set different state sales tax rates that apply to the locality in their state: $T_H \geq T_L$ where $b \equiv T_H - T_L \in [0, 1]$.[4] Like consumers, firms are everywhere. Consumers have inelastic

[4]The model differs from Agrawal (2012) in that it only studies tax competition of towns across the state border and ignores tax competition with other towns in each state. Agrawal (2012) finds two separate effects

demand and must purchase one unit of a consumption good with a pre-tax price normalized to one. The consumer may purchase the good at home, in which case no transportation cost is incurred or abroad, in which case the consumer pays a transportation cost, d, that is linear in the distance traveled, s. The two towns set local tax rates in order to maximize local tax revenue while competing in a Nash game. The town in the high-tax state sets a rate t_H and the town in the low-tax state sets t_L.

Letting V be the reservation price of the good and assuming that V is sufficiently high enough that all consumers but the good, an individual in the high-tax state will purchase the good in the other jurisdiction if $V - 1 - t_L - T_L - ds > V - 1 - t_H - T_H$ which implies that consumers that are within

$$\frac{b + t_H - t_L}{d} \tag{1}$$

units of the border will engage in cross border-shopping if $t_H + T_H < t_L + T_L$; otherwise, no one will cross-border shop. A similar cutoff rule can be derived for the neighboring town. and if the surplus of shopping online is greater than the surplus of shopping abroad. Similar expressions can be derived for the other town.

3.1 No Online Shopping

As a benchmark, consider the case where no one has access to the Internet for online purchases. When no shoppers have access to online transactions, local tax revenue in the two jurisdictions can be constructed as:

$$R_H = t_H(1 - \tfrac{b+t_H-t_L}{d}) \quad , \quad R_L = t_L(1 + \tfrac{b+t_H-t_L}{d}) \tag{2}$$

Noting that the revenue functions in equation 2 are continuous when the direction of the inequality $t_H + T_H < t_L + T_L$ flips, I can differentiate the revenue functions to solve for the best responses and the Nash equilibrium. Using superscripts to denote the equilibrium tax rates, the tax differential between the two jurisdictions is given by:

$$t_L^N - t_H^N = \frac{2b}{3}, \tag{3}$$

of state tax differentials on local tax competition. The first is a level effect: in a local region of the border, tax rates are higher on the low-tax side of a state border than on the high-tax side of a state border. The second effect is a tax gradient: local taxes fall away from high-tax borders and increase away from low-tax borders. By focusing only on two bordering municipalities, this model will focus on the level effect near the border and will ignore tax gradient effects away from the border. Regarding the exogeneity of state tax rates, state tax rates will not depend on any one municipal choice if towns are small relative to the state tax base. This is a simplifying assumption of the model.

and consistent with Agrawal (2012), the town in the low tax state sets a higher local option sales tax. For a Nash equilibrium to exist it must be that d is sufficiently large; I maintain this condition throughout. Now I proceed in two extreme cases: one where the Internet acts as a conduit for the purchase of tax-free goods and second where the Internet helps consumers buy taxable goods.[5]

3.2 The Internet as a Tax Haven

Now, consider the case where a revenue leakage exists. Tax-free online sales are an example of a possible revenue leakage. In the presence of tax-free online sales, some individuals purchase goods online at tax revenue declines in the two jurisdictions. The purpose of this section is not to formally model this process of revenue leakage, but rather to show that when e-commerce is tax free, the effect of these sales on tax rates will be different depending on whether the locality is in a high- or low-tax state. I model tax revenue leakages to online sources by being agnostic as to the source of the revenue leakage. Individuals previously shopping at home may be the source of the revenue leakage; equally possible is that the leakage in the low-tax jurisdiction arises from less cross-border shoppers coming from the neighboring jurisdiction.

To model revenue leakages to tax-free sources, assume that the tax revenue lost is given by the function $f(t_i, \theta, t_i + T_i)$ where $f(0, \theta, T_i) = 0$, $f_1 > 0$ and $f_{11} > 0$ for $t_i \geq 0$, and $f_2 > 0$ and $f_3 > 0$. Denote $\theta \in [0, 1]$ as a parameter that captures the fraction of consumers with access to the Internet.[6] Notice that this functional form implies that the number of individuals purchasing tax-free goods is increasing in the total tax rate as well as increasing in the local tax rate alone. Tax evasion is increasing at an increasing rate with respect to the local tax and that some revenue is lost to the Internet as soon as the total tax rate is non-zero. Modeling tax evasion of the sales tax is likely to be extremely different from standard models of income tax evasion (Slemrod 1994; Slemrod 2001) where the cost of evasion is increasing in the amount evaded. In this model, demand is inelastic. However, even if demand were not fixed, the cost of making more online purchases is not likely an increasing function.[7] Furthermore, revenue leakages are increasing the larger the fraction of

[5]Unifying the two cases would make the jurisdictions have offsetting effects; however, which effect dominates would be functional form dependent and sensitive to the assumptions of the model. Rather I wish to show that two offsetting effects can arise and that they will have a different impact on tax rates for towns in high-tax states than in low-tax states. I then leave it to the empirical analysis to unifying the two channels and determine which one dominates.

[6]I restrict θ to be the same in both jurisdictions. For spatially proximate jurisdictions, it is unlikely that Internet penetration rates vary; this is verified in the empirical section to follow.

[7]The use tax – or taxes due on purchases from the Internet – is easily avoided. Data on use tax compliance suggests that compliance rates are extremely low (Manzi 2012). Given that states have not placed resources

consumers with access to an avoidance technology. To obtain a closed form solution assume that the revenue leakage function is a quadratic function in the local tax rate: $\frac{\theta}{2}t_i(t_i + T_i)$. Thus revenue lost increases in the tax rate and is proportional to the fraction of residents with access to the Internet.

The revenue functions are now $R_H = t_H(1 - \frac{b+t_H-t_L}{d}) - \frac{\theta}{2}t_H(t_H + T_H)$ and $R_L = t_L(1 + \frac{b+t_H-t_L}{d}) - \frac{\theta}{2}t_L(t_L + T_L)$ and the Nash equilibrium in the presence of the Internet as a tax haven (derived in the appendix) is characterized by:

$$t_L^I - t_H^I = \frac{(4 + d\theta)b}{6 + 2d\theta}. \tag{4}$$

In the appendix, I show that $\frac{\partial t_H^I}{\partial \theta} < 0$ and $\frac{\partial t_L^I}{\partial \theta} < 0$. Intuitively, more consumers with access to an avoidance technology will place downward pressure on tax rates. More important to the empirical design to follow is that

$$\frac{\partial(t_L^I - t_H^I)}{\partial \theta} = \frac{-db}{2(3 + d\theta)^2} \leq 0, \tag{5}$$

which indicates that the tax rate in the high-tax state must fall by less than the tax rate in the low-tax state in response to an increase in Internet access in both jurisdictions. The effect of a change in Internet penetration will only be symmetric when $b = 0$. Thus, the tax haven effect of online shopping will be strongest in low-tax states. Intuitively, this arises because residents of the high-tax state already have access to low-tax goods through cross-border shopping. As a result, the higher state tax rate already constrains municipal tax rates in high-tax states. Thus, an increase in access to online goods in the high-tax state has a muted effect on the equilibrium tax rate because revenue leakages (as realized by its lower tax municipality) due to online shopping are smaller in the town in the high-tax state: $\frac{\theta}{2}t_L^I(t_L^I + T_L) > \frac{\theta}{2}t_H^I(t_H^I + T_H)$.

Proposition 1. *When online sales are not taxable, revenue leakages from e-commerce will place downward pressures on tax rates. An identical increase in Internet penetration in both jurisdictions will, however, lower tax rates in low-tax states by more than in high-tax states.*

Notice as well, that by extension, the asymmetries between towns in high- and low-tax states are increasing in b. That is to say, that the larger the tax differential at the state

into enforcing use tax compliance, its unlikely that extra dollars of online purchases would trigger a tax audit. Thus, it seems reasonable that the cost of engaging in tax avoidance or evasion by purchasing tax free goods is likely (near) costless to the taxpayer. Of course, purchasing goods online may result in shipping costs, but these shipping costs may actually be lower than the opportunity costs of going to a store in your home jurisdiction and purchasing the good.

border, the more likely that Internet penetration will have an asymmetric effect across the jurisdictions.

3.3 The Internet as an Anti-Haven

Up until now, I have assumed that purchases on the Internet are tax free. But what if the Internet purchases are taxed because they are made on an online site that has nexus in the state? To model this, I assume that some individuals have a preference to shop online and pay sales taxes to their jurisdiction even if they could have purchased the good from a lower-tax jurisdiction. Individuals may engage in such transactions if they derive utility from online shopping or if the cost of purchasing online (for example, the breadth of goods available on walmart.com may be larger than from a brick-and-mortar store; consumers may have access to online reviews that allow them to make a more informed decision) is sufficiently low relative to the opportunity cost of driving to a brick-and-mortar store. Assume that the number of individuals with a preference to shop online is linearly increasing in the θ is a parameter that captures the fraction of consumers with access to the Internet.

When online sales are taxable, some residents previously buying from brick-and-mortar stores within their home jurisdiction now shop online; this does not affect the revenue function of the jurisdiction. However, residents with high preferences to buy goods online and who previously purchased their goods by traveling to the neighboring jurisdiction will now buy online. Under the assumption that this reduces the number of cross-border shoppers by $1-\theta$ times. the new revenue functions are given by $R_H = t_H(1-(1-\theta)\frac{b+t_H-t_L}{d})$ and $R_L = t_L(1+(1-\theta)\frac{b+t_H-t_L}{d})$. The Nash equilibrium in the presence of this anti-haven is given by:

$$t_L^A - t_H^A = \frac{2b}{3}. \tag{6}$$

and as crucially shown in the appendix, $\frac{\partial t_H^A}{\partial \theta} = \frac{\partial t_L^A}{\partial \theta} > 0$. Intuitively, more individuals with a preference to shop online will mute the Nash competitive pressures and will place upward pressure on the tax rates. Because consumers in the high-tax jurisdiction who now shop online are potential losses to the low-tax jurisdictions, the upward pressure is the same in both the high- and low-tax state. In this scenario, by exploiting people's preferences to shop online, the Internet lowers the marginal cost of raising revenue through the sales tax; jurisdictions can worry less about lost use tax revenues from cross-border shopping.

Proposition 2. *When online sales are taxable and some consumers have a preference to buy online, an increase in Internet penetration in both jurisdictions will raise tax rates in both jurisdictions.*

Of course, the question arises as to whether the effects in proposition 1 or 2 dominate. Allowing the theoretical model to shape the empirical research design, I now proceed to test this empirically.

4 Cross-Sectional Analysis

4.1 Data

I have sales tax data on every town, county, state and sub-municipal district from Pro Sales Tax's national database.[8] States without local sales taxes are excluded from the analysis; towns that set a tax rate of zero are included in the analysis if they are in a state allowing for local taxes. The tax data contain state, county, municipal, and sub-municipal (district) tax rates for December 2011 and the total tax rate in a jurisdiction is the sum of the rates. For each town in the tax data set, I calculate the minimum driving time from the population weighted centroid to the nearest state border. Additional details about cleaning the tax data set and calculating driving distance are in the appendix.

I merge the tax data with data on Internet penetration from the National Broadband Map, which is collected by the National Telecommunications and Information Administration (NTIA) in conjunction with the Federal Communication Commission.[9] The data on Internet penetration used is from July 2011. The National Broadband Map collects data at the state, county, and Census Place level. Using firm level data and service maps provided by these firms, the NTIA matches service maps to Census block maps. In doing so, they are able to calculate the fraction of people within a Census block that have access to particular types of Internet service and can then aggregate this information to the county and place level. The National Broadband Map provides data on the percent of the population that have access to any type of Internet service, access to wireless service, and wireline service. In addition to having access to service, I also know the percent of households with access to various types of services (DSL, Copper, Cable, etc.) and the percent with access to various download and upload speeds. I also know the percent of individuals who have access to more than one provider of Internet services, more than two providers, more than three providers, etc. A provider is defined as a firm such as Charter or AT&T.

[8]The data are proprietary data. For a complete description of the data, see http://www.prosalestax.com/.
[9]For a complete description of the data please see the website http://www.broadbandmap.gov/ .

4.2 Summary Statistics

Because the threats to causal identification that I will face are inherently spatial, I present maps showing the distribution of local tax rates and the percent of the population with access to four or more providers in Figures 2 to 3. With regard to the distribution of taxes, I only map the data at the county level. County tax rates have much less variation than local tax rates within a state. For this reason, I will focus on towns. Although much of the within state variation (often about a percentage point) is swamped out by the cross-state variation, the map still demonstrates that variation within a state is noticeable.

The appendix shows maps demonstrating that simple measures of access to any technology have almost no variation within a state; almost all towns have at least one technology available. Many communities in the United States have high percentages of their population with access to the Internet but with very low-take up rates of Internet usage. In terms of Internet penetration, 98% of people live in an area with wireless penetration while a little over 90% of the population lives in an area with wireline penetration. The national numbers from the Consumer Population Survey (CPS indicate) that 65.04% of people use the Internet at home while 71.69% of the population live in a household with access. Because wireless and wireline penetration have little variation, it is likely to be of little use with regard to the actual usage of Internet within jurisdictions, which is what a competitive government likely cares about. One reason for this difference is that in many areas of the country access to the Internet is not in a perfectly competitive market for broadband, but rather through a market where one provider has monopoly power. In fact, many counties have only a single provider operating within their borders. For this reason, Figure 3 shows the percentage of residents with access to four or more providers. In markets with more providers, the price of an Internet subscription is likely lower, which should stimulate the number of homes with usage at home. The figure indicates that there is ample variation within a state.

Table 1 shows the summary statistics in numerical form for Census Places and Counties across states allowing for local sales taxes. All of the variables in the table starting with number of neighbors are used as controls in the regressions and also help to control for public good preferences

To give the reader an idea of how important e-commerce is, Figure 4 shows the growth of online sales using United States Census data for e-commerce sales retail sales and the percentage of sales. Although by 2011, online sales were about 5% of total sales – and tax free sales were a smaller fraction, news stories, council meetings, and state legislature debates indicate that lawmakers are already extremely concerned about online sales.[10] Although 5%

[10]In fact, many states, such as Georgia have tried to redefine what it means to have nexus in state in order to capture online sales tax revenue. States do this by passing "click through" nexus rules.

of retail sales may seem small, policymakers are extremely concerned about this issue.

4.3 The Baseline Regression Specification

A simple cross-sectional regression specification that can be used to determine how the Internet influences tax competition takes the form:

$$\tau_i = \alpha + \beta I_i^* + \zeta + \sum_m X_{im}\gamma_m + \epsilon_i, \quad (7)$$

where τ_i is the local (municipal tax rate) in town i, I_i^* is a measure of Internet *usage* in the town, ζ are state fixed effects, and X_{im} is one of m control variables. Depending on the specification, τ_i is either the total local tax rate (county plus town) or the local tax rate. Within the set of controls are all of the geographic, political, and demographic variables listed in Table 1. I also include a dummy variable for whether the jurisdiction is proximate to an international border or to a major body of water; the latitude and longitude of the population weighted centroid are additional controls designed to capture and geographic or topographical features that change from east to west or north to south within a state. The specification does not control for state tax rates, which are picked up through the state fixed effects along with other state-by-state institutional differences in state-based rules governing the localities.

Ideally, local policymakers set tax rates on the basis of the fraction of people who are able (and willing) to use the Internet. This would suggest that the best measure of I_i^* would be the fraction of people who use the Internet at home; however, the CPS does not distribute this data at any level below the metropolitan area. I observe the Internet penetration at the municipal level. Defining I_i as a measure of Internet penetration from the National Broadband Map, if

$$I_i^* = \lambda + \delta I_i + \nu_i \quad (8)$$

and δ is significantly different for zero, then Internet penetration proxy can be used as a proxy for Internet usage. Of course, simply plugging in the penetration measure for the access measure in the first equation will create attenuation bias on the true coefficient of interest, β, because usage is measured with error. Because this will bias me against finding an effect, I am estimate

$$\tau_i = \alpha_0 + \beta_0 I_i + \zeta + \sum_m X_{im}\gamma_{0m} + \epsilon_i. \quad (9)$$

Alternatively, one may argue that policymakers know the penetration rate – I_i – because the data are publicly available – but do not know the Internet usage rate I_i^* for their municipality. If this is the case, local tax policy is expected to respond to the observable variable. Then, equation 9 will be the true policy reaction function and no measurement error issues will arise.

The National Broadband Map contains data on a variety of measures of Internet penetration including: the percent of the population with access to (i) any service provider, (ii) wireline providers, (iii) wireless providers, (iv) more than a particular number of providers servicing the area, and (v) speeds of service available. To determine which measure acts as the best proxy for Internet usage, I run a regression of the form in equation 8 using Internet penetration data at the state level from the broadband map as I_i and Internet usage from the CPS as I_i^*.

The CPS regularly publishes supplementary data on "Computer and Internet Use." The most recent publication of this supplement was from October 2010. In this supplement respondents are asked "At home, do you or any member of this household access the Internet?", "At home, do you access the Internet?" and "Do you or any member of this household access the Internet at any location outside the home?". The CPS provides aggregated statistics at the state level. Using this data, I am able to match state level data on Internet penetration from the NTIA with Internet access statistics from the CPS.

The proxy variable is selected as the variable that maximizes the R^2 of the univariate regression and has a significant coefficient. In doing this exercise, I assume that the correlations that I observe at the state level are also representative of the cross-section of lower levels of governments.[11] Table 2 summarizes the results of this exercise for some of the possible proxies. Each row of column 1 reports the estimated value of δ and R^2 of equation 8 with no other controls.

Table 2 indicates that the fraction of individuals with access to any type of Internet service are not strong proxies for Internet usage. In fact, simply having access to two or more providers is also a weak measure of Internet usage. Access to three or more providers demonstrates a strong (positive) relationship between penetration and usage. This strong correlation is remains for having access to four or more providers and five or more providers. The fraction of people with access to four or more providers yields the strongest R^2 measures and for this reason it is the preferred metric that I use throughout the paper. Metrics of speed exhibit very week correlations and speed is unlikely to influence online shopping. The

[11] I also construct measures of Internet access using the CPS at the county level and at the principal city level within an MSA. Looking at these results it becomes clear that they are not good measures of usage for two reasons. (1) The CPS sample is not representative of the population at geographic levels below the state level and (2) counties that are identified in publicly released CPS data are likely to be disproportionally large.

appendix shows the results are robust to using other proxies from the list.

The question remains as to why more providers performs much better than broader measures of Internet access. Perhaps competition is more intense in high income or dense areas, in which case the simple univariate regression is picking up the effect of these variables. To test this, I run the same regression controlling for various demographic characteristics. After doing so, the presence of multiple providers remains statistically significant; although the additional increase to the R^2 of the Internet variable above and beyond the demographic controls is now smaller, it is still approximately 3%.

The existing literature also provides some theoretical evidence that increased competition by broadband companies will increase take-up of the Internet. For example, the theoretical model of Faulhaber and Hogendorn (2000) establishes a three stage game where firms first choose which households to serve and then traffic capacity and price. Faulhaber and Hogendorn (2000) shows that "the subgame equilibrium capacity and price strategies depend only on the number of networks to which a household has access." Thus, the number of providers serving an area (the outcome of the first stage) is from a theoretical perspective the most important determinant of price in this industry. Another explanation of how competition increases Internet usage is through access to more differentiated products. As shown in Distaso, Lupi and Manenti (2006) and verified empirically, inter-platform competition such as DSL versus cable technologies (rather than intra-platform competition), increase Internet usage. Prieger and Hu (2008) also show empirically that competition in broadband markets is an important contributing factor of the Digital Divide that exists across races even though prices do not vary substantially across various markets; the authors argue that more intense competition increases Internet usage as companies compete more intensely on installation, service fees, and other charges. All of this evidence taken together suggests that markets with more intense competition will have higher Internet usage rates, which should then feed back into the tax setting behavior of the jurisdictions. The precise mechanism through which this occurs is debated – lower prices, lower service fees, or product variety – but the precise mechanism is not important to this paper. What is important is that competition in broadband is an important determinant of usage.

Before turning to the local level, I show scatter plots using state level data (plus the District of Columbia) because I_i^* is observed in the CPS data. I present correlations of state tax rates and measures of Internet usage from the CPS. The results of this exercise are summarized in Figure 5. Having access to the Internet outside of the home has no relationship with the state sales tax rate. This result is expected because its not likely that individuals are using cafe cyberstations or work computers to do the bulk of their shopping. The question asking whether individuals use the Internet at home shows a negative relationship with sales taxes, as does the fraction of people living in a household where one person has access to the Internet.

4.4 Cross-sectional Results and Fractional Response Models

Table 3 shows the results of the specifications at the town level using both the total local rate (town plus county) and the town rate as the dependent variable. The regression results without any controls shows no effect of the Internet; it is highly unlikely that using across state variation yields satisfying results given the institutional differences in tax policy across the states. However, column (2) – including all the controls listed in the appendix and state fixed effects – shows a significant effect of an increase in Internet penetration on the total local tax rates. The coefficient is -0.050, which indicates that a 100 percentage point increase in the Internet penetration rate (going from a world with no Internet access, to complete access) decreases the local tax rate by .050 percentage points.[12] Keeping in mind that the average local sales tax rate is 1.77 percentage points, a hundred percentage point increase in Internet penetration has about a 3% decrease in local tax rates. Keep in mind that Internet penetration rates have not increased a hundred percentage points in recent years; the average town has a usage rate of about 70% of the population. Results for town level tax rates alone suggest a smaller response; given that towns are smaller than counties, this immediately suggests a role for heterogeneous responses on the basis of jurisdiction size.

Another worry is that tax rates are constrained to be between zero and one, but estimation using ordinary least squares (OLS) places no restrictions on the predicted values. In fact, OLS may result in predicted values that are well outside this interval; furthermore, the linear form may miss important non-linearities that arise in the fractional case. As is well know, estimation of censored data using OLS will yield biased estimates. As a result, I implement a fractional response model. To my knowledge, this represents the first study of tax rates that addresses these issues and thus makes a methodological contribution to this literature.[13] I follow the methods of Papke and Wooldridge (1996), Papke and Wooldridge (2008), and Wooldridge (forthcoming). In the fractional response model, the left hand side variable in equation 9 is allowed to take on values $0 \leq \tau_i \leq 1$ where the extreme values can occur with positive probability. The researcher then estimates a general nonlinear model under the assumption that

[12] The effect of a one percentage point increase can be found by dividing all the estimates by 100 in each of the tables. All tables – including the fractional response results are presented on this scale.

[13] The fractional response model is more appropriate than a Tobit model in this context.

$$E(\tau_i|\mathbf{x}_i) = G(\mathbf{x}_i\beta) = G(\alpha_0 + \beta_0 I_i + \zeta + \sum_m X_{im}\gamma_{0m}) \tag{10}$$

where $\mathbf{x}$ are the right hand side variables from equation 9 and $G(\cdot)$ is some function that will result in predicted values between zero and one. To mechanically implement this, I apply quasi-maximum likelihood estimation (QMLE) using a Bernoulli log likelihood function where I use the probit functional form for the mean response in order to bound the predicted tax rates.[14] Because the model is non-linear, I always present marginal effects (mean derivatives) defined as $\partial E(\tau_i|\mathbf{x}_i)/\partial I_i$. Comparing the fractional response marginal effects, with the OLS results yields a slightly higher estimate that suggests non-linearities and bounding the tax rate variable between zero have important consequences. The $R^2$is higher in the fractional response model; as in Papke and Wooldridge (1996) I define the $R^2 = 1 - SSR/SST$ such that it is comparable across models.

4.5 Heterogeneity In Responses

The theoretical model suggest two channels are at work: a revenue leakage effect and an anti-haven effect. Which of these effects dominates may depend on characteristics of the jurisdiction; one often studied characteristic is the role of jurisdiction size.[15] The empirical results in table 3 suggest that jurisdiction size may play a role – when looking at tax rates inclusive of the county rates, the effect of the Internet is larger.

The average town in the sample has less than 10,000 people and most likely does not have a single big-box brick-and-mortar store. In fact, some of the towns in the sample may require the individual to drive upwards of half an hour to find the closest mall or major retail shopping center. As a result, such a jurisdiction has no tax base in a world where no one has access to the Internet and the use tax is not enforced; everyone would leave this town to go to a nearby jurisdiction to purchase goods. In the presence of the Internet, two things happen: (1) some individuals who previously went to nearby shopping centers purchase their goods on tax-free site such as Amazon.com and (2) some individuals who previously went to nearby shopping centers purchase their goods on taxable sites from retailers with nexus in the state such as Walmart.com. A key point to this analysis is that the fraction of online shoppers who purchase goods from taxable sites is likely highest for small rural jurisdictions rather than from urban or suburban locations with retail stores. The intuition is that individuals in large

[14] In the original fractional response paper, a logit was used. In subsequent papers, probit functions have been used mainly to extend the model to IV applications, which I will do in subsequent sections. The results are robust to using the logit distribution.

[15] For example, Kanbur and Keen (1993), Nielsen (2001) and Trandel (1994) show that population is an important determinant of tax rates.

metropolitan cities or suburbs are likely to have a brick-and-mortar version of the taxable online store. For this reason, individuals near retail stores need not shop on Walmart.com to benefit from the full variety of goods offered by the store. This possibility is not available to a rural shopper – who must drive (at possibly quite significant costs) to the nearest Walmart. The question remains as to why individuals would purchase the good from Walmart.com rather than from a tax-free site such as Amazon. There are several explanations: (1) the variety of products from a big-box-retailer may be much larger than from Amazon or eBay, (2) many of the diverse products offered on Amazon.com and all of the products on eBay come from third party vendors where the buyer needs to deal with reputation effects, and (3) consumers likely want to get products as quickly as possible.[16] Because tax revenue can now be easily collected from taxable online sales, more consumers with access to the Internet will effectively lower the marginal cost of raising tax revenue through the sales tax; the effect will be strongest in small jurisdictions.[17]

To test for heterogeneity, I split the sample in two: based on jurisdictions that are above the median population size and based on jurisdictions below the median size.[18] A split sample approach is preferable to interacting I with the log of population – which would impose strong functional form assumptions. Table 4 shows that the response of small town tax rates is statistically indistinguishable from zero, but that the response in larger towns is ten times as large and significantly negative – suggesting that local tax rates are 10% (.075/.77) lower as a result of a change from zero to complete Internet penetration. This implies that the tax haven effect is stronger in large jurisdictions than small jurisdictions. If splitting the sample at the mean, going to complete Internet penetration lowers municipal tax rates by almost two tenths of a percentage point.

This result is consistent with a world where most brick and mortar shopping occurs in relatively large jurisdictions, thus implying that taxable online sales lower competition (and raise tax rates) moreso in rural areas. However, the insignificant result in small towns does not allow me to conclude that the anti-haven effect is stronger in small towns. While the insignificant coefficients are consistent with such a story, it may also be the case that small towns are less sophisticated or changes their tax rates infrequently.

[16] From Amazon's perspective, the last point seems to be important. Amazon has recently agreed to collect sales taxes in several states so that they can construct warehouses in the state in order to get products to market as fast as possible. Amazon also supports the Marketplace Fairness Act of 2013 because it realizes that it is moving toward a business model that has distribution centers in many states.

[17] Jurisdictions with very small populations may also be less sophisticated in their tax setting behavior than large jurisdictions. If small jurisdictions are less sophisticated (and perhaps less strategic as a result), these small jurisdictions may see revenue declines over time and instead of reducing their tax rate to mute the effects of the Internet, they may raise the tax rate in an attempt to satisfy a revenue requirement.

[18] The heterogeneity only becomes starker if I split the sample based on the mean.

5 Exploiting Discontinuities at State Borders

A threat to identification is a spatially correlated omitted variable. An additional concern is that Internet penetration picks up an effect other than tax competition, such as the degree of connectivity of the jurisdiction, which in turn influences tax rates. I exploit a borders based approach to identifying the causal effect on tax rates.

To find a causal effect, I exploit the fact that borders result in discontinuous changes in state sales tax rates. These discontinuous changes in the state tax rates should impact how the municipality reacts to a change in the fraction of individuals with Internet access. For towns on the high-tax side of the border, the municipal government will be worried about the revenue leakage to the Internet and to the nearby low-tax state. Because tax differentials at state borders average two percentage points, the incentives to engage in cross-border shopping are potentially quite large. The most recent estimate of the elasticity of cross-border shopping places it at unity. (Tosun and Skidmore 2007). As indicated in the theoretical model, for municipalities on the low-tax side of the border, the tax haven effect of the Internet should be more pronounced as consumers in this state cannot shop across the state line – and any cross-border shopping that they can engage in will be with nearby jurisdictions, where tax differentials are likely to be much smaller. Towns on the high-tax sides of borders are less likely to have retail stores than those on the low-tax side of the border, as firms elect to locate on the low-tax side of the discontinuity. Consider the extreme example of Massachusetts (6% tax) and New Hampshire (0% tax). For a Massachusetts town right on the border, residents can avoid the Massachusetts sales tax by crossing over the border and buying tax free goods. In fact, this arbitrage opportunity is made easier by the fact that as you drive across the border, most of the retail stores are located on the New Hampshire side. The costs of traveling to the border for a resident of a town on the border is quite negligible. Thus, having a tax-free Internet is not likely to place any added pressure on the jurisdiction to lower its tax rate. In fact, as shown in Agrawal (2012) municipalities on the high-tax side of borders already lower their tax rates dramatically to mute cross-border losses. Agrawal (2012) shows that towns in relatively high-tax states set dramatically lower local tax rates than similar neighbors on the low-tax side of the border. This level effect constrains municipalities in high-tax states to have tax rates that are on average 1.25 percentage points lower. Because municipalities are already lowering their tax rate because of their spatial location relative to the border, the presence of a tax-free Internet has a small effect.

For a town on the low-tax side of the border, the incentives of the jurisdiction are the opposite. Consider a resident of Alabama (4% tax) and Tennessee (7% tax). As a result of the tax differential, a municipality exactly on the border in Alabama cannot engage in cross-border shopping to the north. Residents may shop in other nearby towns within Alabama but because jurisdictions mimic their neighbors and are similar along other observables, it is likely that local tax rate differentials are less than a percentage point. For this municipality, an increase in the number of Internet shoppers will lower tax rates as the jurisdiction needs to react more intensively to the threat of a tax-free Internet. Furthermore, because the town is on the low-tax side of the state border, it is likely that more brick-and-mortar firms locate in the town. As this happens, residents who do shop on the Internet are less likely to use remote taxable sources such as Walmart.com because they are more likely to have a Walmart in town. Instead the competition comes from the tax-free Internet. As is Agrawal (2012), these towns set much higher tax rates than similar localities in the neighboring state; but this upward pressure is muted by the presence of the Internet.

On the other hand, the theoretical models shows that the anti-haven effect is the same on both sides of borders. Thus, taken together with the heterogeneity results, the tax haven effect should be asymmetric depending on the side of the border – especially so for large jurisdictions. The anti-haven effect should should be symmetric on both sides of the border – especially noticeable for very small jurisdictions where the effect dominates.

This borders-based approach also provides evidence that the channel through which the Internet influences tax rates is competitive (consistent with tax evasion across borders) rather than the degree of connectivity or information that policy makers have (or some spatially correlated variable). If this last effect were at work we would not expect asymmetric responses to the Internet to be as pronounced across borders – especially in a very local region of the border. To exploit this identification strategy, I implement :

$$E(\tau_i|\cdot) = G(\alpha_0+\beta_0 I_i+\beta_1 H_i+\beta_2 I_i H_i+\sum_{k=1}^{3}\delta_k(d_i)^k+\sum_{k=1}^{3}\rho_k I_i(d_i)^k+\sum_{k=1}^{3}\lambda_k I_i H_i(d_i)^k+\zeta+\sum_{m}X_{im}\gamma_m), \tag{11}$$

where X_{im} is one of m control variables, $\zeta$are state fixed effects, H_i is a dummy for whether the town is located in a relatively high-tax state relative to its nearest neighbor, and G is the same function as defined in 10. The interaction terms with I_i allows Internet penetration to have a different effect on the high-tax side of the border compared to the low-tax side of the border. [19] In the above equation, I also include several flexible distance functions.[20] The

[19]I exclude observations for which the nearest neighbor is a same tax neighbor. Alternatively, I could classify towns at same tax borders as being "high" tax or "low" tax in the dummy variable. The results are robust to this, but the interpretation of the marginal effects becomes more nuanced. Relatively few towns (3%) are proximate to a border where the tax differential is small.

[20]In all town level specifications, I will always use a cubic time to the state border as the distance function and I will restrict the sample to towns within one hundred minutes of driving time to the nearest state

first polynomial in distance $\sum_{k=1}^{3} \rho_k I_i(d_i)^k$ captures the effect of distance from the border on local tax rates independent of the Internet.[21] The term $\sum_{k=1}^{3} \rho_k I_i(d_i)^k$ allows for Internet penetration to have a heterogeneous effect on taxes depending on proximity to the border. The term $\sum_{k=1}^{3} \lambda_k I_i H_i(d_i)^k$ allows for this effect to be different on the high-tax side of the border compared to the low-tax side of the border.

The goal of this exercise is to see if the Internet has a differential response in high-tax states compared to low-tax states. In specific, I am interested in how this effect differs as distance to the border approaches zero $d_i \to 0$. In the limit, I can compare bordering towns in high-tax states with bordering towns in low-tax states; because I use driving time as the metric of distance, these towns share common linkages, labor markets, and amenities. Therefore, I will explicitly focus on town tax rates alone because counties in the United States can be relatively large and it is less clear how to think of this limiting case. I maintain the split sample analysis given that the previous section demonstrated that there is no significant response to the Internet in small towns; the results for the larger towns will be more appropriate to characterize how the Internet influences tax rates for the average person in America. In addition, I can interact terms in the regression specification above with the tax differential at the border to determine where the response is largest.

A threat to identification using a border-based approach would occur if Internet penetration changes discontinuously at state borders conditional on observables. I test whether this is the case by regressing the measure of Internet penetration on a dummy variable for the high-tax side of the border, a distance term, the same set of control variables used above, and state border pair fixed effects. Coefficients on the high-tax state dummy variable and the distance term are insignificant and close to zero. The results are reported in the appendix.

In all tables to follow, given the probit specification and the polynomial in distance, I report the mean derivatives (marginal effects) conditional on the side of the border that the town is located within.

5.1 Results

The results in Table 5 (column 2) indicate that when I account for border asymmetries, the marginal effect of the Internet is most negative (.07 percentage points larger) for jurisdictions on the low-tax side of borders. The heterogeneity in responses is twice as large when focusing only on large jurisdictions. This is consistent with a theory where jurisdictions on the high-

border. The restriction of one hundred minutes allows for a less flexible function of distance to the border than if I considered extremely interior jurisdictions. In the appendix, I show that the results are robust to changing this restriction.

[21] I could also include this polynomial interacted with H_i. However, previous work shows that the effect of distance on tax rates is negative on both sides of the border.

tax side of borders are already constrained by state tax rate differences, which mute the effect of the Internet on taxes.

Table 6 shows the heterogeneity as a function of distance to the border. It should be noted that towns near the border on the high-tax side have marginally significant negative effects from Internet access. On the low-tax side of borders, the Internet has the largest downward pressure in towns near the border; this is consistent with the fact that absent the Internet towns near a higher tax state will set higher tax rates than those away from the border and will have more brick-and-mortar stores relative to similar interior towns. On the low-tax side, the effect of Internet penetration decreases over the first 20 minutes of distance at which point it levels off, but remains stronger than the effect for high-tax towns. In the limit, as distance approaches zero and towns on the other side of the border become better controls for the opposite side, it is clear that the effect of the Internet is 2.5 times as large on the low-tax side.

The theory also predicted that municipalities facing the largest tax differentials should have the most asymmetric responses. To test this, I interact the magnitude of the tax differential of the home state minus the neighboring state with all of the listed terms in equation 11 with an I_i variable. Because the tax differential is interacted with the dummy variable H_i, I allow one percentage point increase in the differential to have different effects depending on the side of the border. Panel B of the table shows that municipalities near the border (as $d_i \to 0$) have much larger responses relative to their high-tax state neighbors as the tax differential increases. In fact, comparing towns near borders with 1 percentage point and 5 percentage point differentials implies that the difference is 5 times as large.

5.2 Measurement Error and Multiple Proxies

One downside of the proxy variable based approach is that it introduces concerns relating to measurement error in the independent variable.[22] This measurement error is likely to attenuate the coefficient estimates; given the policy importance of this piece, such attenuation bias could greatly influence policymakers. In all of the above regressions, I am using a single proxy variable that was selected using an R^2 criterion. In reality, I have access to multiple proxy variables – the fraction of the population with access to any number of providers or greater, the fraction of the population with access to various speeds, and the fraction of the population with access to various types of technologies. Lubotsky and Wittenberg (2006) develop a procedure (for linear regressions) that estimates the coefficient of interest even

[22] If policymakers only have access to the data I use, the percent of the population with access to multiple providers may not be a proxy variable and instead may be the actual policy variable, in which case the concerns of this section are mitigated.

if all proxy variables are included in the regression simultaneously.[23] In large samples, the estimator is superior to other methods constructing an ad hoc index or to using only a single variable.

The true model is given by equation 7 where the true policy variable is the fraction of consumers using the Internet for online sales. I have access to n proxy variables denoted p_i. These proxy variables include various measures of Internet penetration at the municipal level. Lubotsky and Wittenberg (2006) show the researcher can run a regression including all of the proxy variables for I^*:

$$\tau = \tilde{\alpha} + \sum_{k=1}^{n} b_k p_k + \zeta + \sum_{m} X_m \tilde{\gamma_m} + \tilde{\epsilon}, \tag{12}$$

and then can aggregate up to a single coefficient of interest using:

$$b^\rho = \sum_{k=1}^{n} b_k \frac{cov(\tau,\, p_k)}{cov(\tau,\, p_1)}. \tag{13}$$

Notice that the expression is normalized by $cov(\tau,\, p_1)$. This normalization means that the procedure is an interpretation procedure where the coefficient is scaled such that a one unit increase in I^* (Internet use for online shopping) will result in a one unit increase in p_1. In order to be able to compare this procedure to my other results, I select do the normalization such that it the results are comparable to the fraction of the population with access to four or more providers. Lubotsky and Wittenberg (2006) show that attenuation bias will be maximally reduced when estimating b^ρ.

The aggregation procedure above is equivalent to creating an index where

$$p^\rho = \frac{1}{b^\rho} \sum_{k=1}^{n} b_k p_k. \tag{14}$$

and then estimating:

$$\tau = \hat{\alpha} + b^\rho p^\rho + \zeta + X\hat{\gamma} + \hat{\epsilon}. \tag{15}$$

Such index creation will yield the same estimate as equation 13. However, having an index variable will allow me to also estimate equation 15 when p^ρ is also interacted with other covariates. As noted in Lubotsky and Wittenberg (2006), it is important to note that the procedure is not a license to throw in every variable the researcher may think is a proxy

[23] All of the results in this section use OLS models rather than the fractional response model given that the procedure was developed for linear regressions. I have also applied the procedure to the non-linear models above and the coefficients effects only marginally from the ones reported in this table.

variable. Proxy variables can influence other control variables (Bollinger 2003) and "adding proxies that absorb the effects of covariates rather than proxying for the latent variable will be particularly damaging." For this reason, I exclude most of the type of technology variables (dsl, optical fiber, copper, etc.); I also exclude the fraction of people with access to 7 or more providers, 8 or more providers, or higher; I exclude the fraction of people with access to very high speeds of Internet access. The summary statistics of these variables indicate that many of the scenarios are relatively uncommon in the data and thus could be highly correlated with the population or income of the jurisdiction. Thus, I use only variables indicating the percent of consumers with access to wireless, any technology, 0 providers, one or more, two or more, ... six or more, download speeds greater than 1500k, and download speeds greater than 3000k. The appendix shows the results are robust to smaller subsets of the possible proxy variables.

The results from Table 7 can be compared to the previous OLS results. As expected, the mean derivatives increase in absolute value across all of the specifications; in many specification they are twice as large. For example, in column 2, the result with the index implies going from no to complete penetration lowers tax rates .122 percentage points. This result can be compared to column (2) of table 3's column 2. Notice that the estimates using the index are twice as large, suggesting that the proxy variable approach used previously biases me against finding results.

Given the results increase in absolute value (and that they are normalized using the same proxy variable utilized in table 3), it suggests that there is more information in using multiple proxies and that use of a single proxy may attenuate my results by about 50%. Given the sign on the coefficients is the same and the results significant even in the presence of this attenuation bias, this suggests that the results in table 3 represent a lower bound on the true effect of the Internet on taxes. The results from using all the proxy variables suggests the true magnitudes of the policy reactions to the Internet are larger and that some of the negative but insignificant results may actually be statistically significant.

5.3 Lightning as an IV for IT

In the above sections, I demonstrate that the results are consistent with asymmetric theoretical predictions on various margins: high- vs. low-tax sides of state borders and high- vs. low-penetration rates relative to neighboring jurisdictions. As a final robustness check, I instrument for the number of providers. In all of the above specifications, I have controlled for both demand and supply side factors that may influence the number of providers in a particular market that are also correlated with local sales tax rates. Demand side factors influencing Internet providers include demographic controls, population, and the income of the jurisdiction, among others. The decision on the supply side are primarily cost factors.[24] Many factors influencing the cost of providing Internet service are historically determined; most wireline providers enter into markets on the basis of whether existing cable or copper lines exist. One further component, which may influence the supply side of the market could be local regulations. Although data on regulations at this fine a local level are not available, I do control for the fraction of votes received by Barack Obama. In this section, I also show that the results are robust to instrumenting for Internet penetration in case the proxy variable or the variable being proxied for are endogenous. I now use an IV strategy as an additional robustness check.

Andersen et al. (2012) show that lightning strikes are a powerful predictor of IT growth in the United States during the period from 1995 to 2006. Andersen et al. (2012) argue that in places with high lightning density, more power disturbances occur. In turn, these power disturbances increase the cost of investing in IT, which then lowers IT investment and Internet usage across the United States. Figure 6 shows the strong negative relationship of IT usage and lightning. This result suggests a possible instrument for Internet access so long as lightning strikes satisfy the exclusion restriction. It is unlikely that lightning strikes directly influence local sales tax rates and are most likely to be correlated with weather conditions or topographical features, which I do not have data on. However, I do control for state fixed effects which picks up broad geographical weather related amenities.

As an instrumental variable, I construct a measure of the flash density per square mile of land per year for every county in the country using the National Oceanic and Atmospheric Administration's Severe Weather Database. I use data on the annual number of ground strikes from 1996 to 2011 to construct the per year average number of strikes per square mile.[25] Define the flash density of lightning in a county

$$lightning_j = \frac{(\sum_{t=1996}^{2011} strikes_{j,t})/16}{area_j}, \tag{16}$$

where $strikes_{jt}$ is the number of lightning strikes in county j in year t and where $area_j$ is the area of the county. Because the $lightning_j$ only varies at the county level, I define the flash density of lightning in municipality i as the average of $lightning_j$ for all municipalities within a ten mile radius of its population centroid. Thus, for municipalities at the interior

[24] For discussions of the demand and supply of broadband, see Nevo, Turner and Williams (2013), Prieger (2007), and Varian (2001).

[25] Andersen et al. (2012) only use data to 2006 and only use state level data.

of the county, $lightning_j$ will be their flash density. But, for municipalities near the border of the county, their flash density will be an average of the flash density on both sides of the border. This tries to capture the fact that lightning densities increase or decrease smoothly over geographical space; averaging simply smooths the data across geographic space.[26] Table 8 presents the results along with statistics concerning the instrument. I present the results where I instrument for the index of Internet penetration. I follow the control function approach of Wooldridge (forthcoming) for an IV strategy in the fractional response model. The results of this exercise are simply meant as a robustness exercise and do not make up the preferred methods; the border design remains the preferred method given that it is grounded in the theory.

In both specifications, the instrument is strong, the test statistic above the critical value, and the sign in the reduced form is negative as expected. The results of the IV exercise confirm the same sign and similar magnitudes from the baseline results. An increase in Internet penetration seems to lower local tax rates by about one tenth of a percentage point. This robustness exercise suggests that endogeneity concerns are limited, however, I am unable to use the IV strategy in a border design because I would be required to instrument for many interaction terms. The IV results taken together with the border design, which is grounded theoretically, is strong evidence that the channel through which the Internet influences local tax rates is through the added downward pressure that a tax-free "haven" places on tax competition.

6 Conclusion

E-commerce represents a non-trivial fraction of commodity purchases. Purchases from remote vendors without nexus are tax free while purchases from online vendors with nexus in a state are subject to state and local sales tax collection. Governments seeking to maximize revenue in a competitive game, will account for any revenue leakage to the Internet when setting tax rates. I modify models of tax competition to account for the Internet. If the Internet acts as a tax-free source, towns in low-tax states will be most adversely affect by e-commerce. Jurisdictions in high-tax states will have a muted response to the tax haven pressures of e-commerce even though revenue leakages are increasing in the state tax rate. If the Internet is taxed, then Internet sales are an effective way of collecting state and local use tax revenues; this mutes competitive pressures between jurisdictions as some cross-border shoppers now buy online due to preferences or low costs of buying goods online. I demon-

[26]See maps of flash density provided by Vaisala. The maps indicate that lightning strikes are smooth across large geographies – due to it being a relatively natural phenomenon.

strate theoretically that this may place upward pressure on tax rates through an anti-haven effect.

Empirically, using a cross-section of state and local sales tax rates and data on Internet penetration that is tracked at the county and Census place level, I show that the Internet does have a significant effect on the tax rates of municipal jurisdictions. For small jurisdictions (with a population of less than 1200), the effect of more online shoppers has a negligible effect on local tax rates. This may be a sign that the anti-haven and tax haven effects offset each other; or it may indicate these jurisdictions are not strategic. For larger jurisdictions, the effect of more online shoppers places downward pressure on tax rates. I exploit a border-based approach to show that the results are causal. Specifically, I demonstrate that the Internet places strong downward pressure on municipal tax rates in large jurisdictions on the low-tax side of the state border. The effect is muted on the high-tax side of the border. As distance from the border approaches zero, the effect of e-commerce becomes three times as large in low-tax states. Furthermore, the effect of e-commerce has the largest asymmetries at borders with large tax differentials. This result is consistent with jurisdictions on the high-side already being constrained because of cross-border shopping that occurs across state borders. The results are generally consistent with the Internet being viewed as a tax haven for sales tax evasion by municipalities, which places downward pressure on tax rates in a tax competition setting.

Numerous studies (Ballard and Lee 2007; Goolsbee 2000; Goolsbee, Lovenheim and Slemrod 2010; Einav et al. 2013) show that consumers are responsive to tax differentials resulting from online shopping. Because the Internet influences the elasticity of demand for goods and because the elasticity of demand is an important determinant of tax rates in the context of fiscal competition, a natural next step is to determine how differences in Internet penetration distort tax rates. This paper represents a first attempt at doing so. Natural extensions of this paper may seek to exploit the rash of "natural experiments" occurring as we speak. Amazon.com's agreements with several states to collect state and local sales taxes provide the researcher with a nice event study based approach to study the effect of nexus on tax-setting behavior. Given the staggered nature of the timing of the event across states, future studies may be able to derive causal effects. If the Marketplace Fairness Act of 2013 passes, the results of this study indicate that the collection of online sales taxes may place upward pressure on tax rates if residents have a strong preference for online shopping. Certainly, as more and more states expand their definitions of nexus, the results of this paper suggest that tax rates will rise and jurisdictions find ways to mute the effect of the Internet as a tax haven. Beyond that channel, online sales tax collection has the potential to lower the marginal cost of collecting tax revenue using the sales tax relative to other tax instruments;

as this happens, the anti-haven effects discussed theoretically will likely arise placing further upward pressure on tax rates.

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Figure 1: Geography

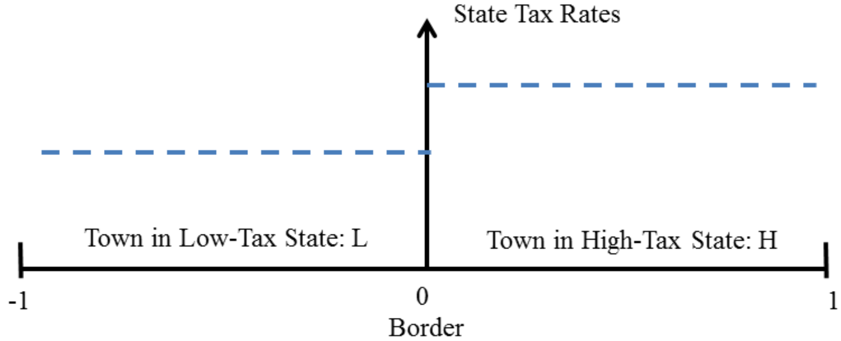


Figure 2: County Tax Rates

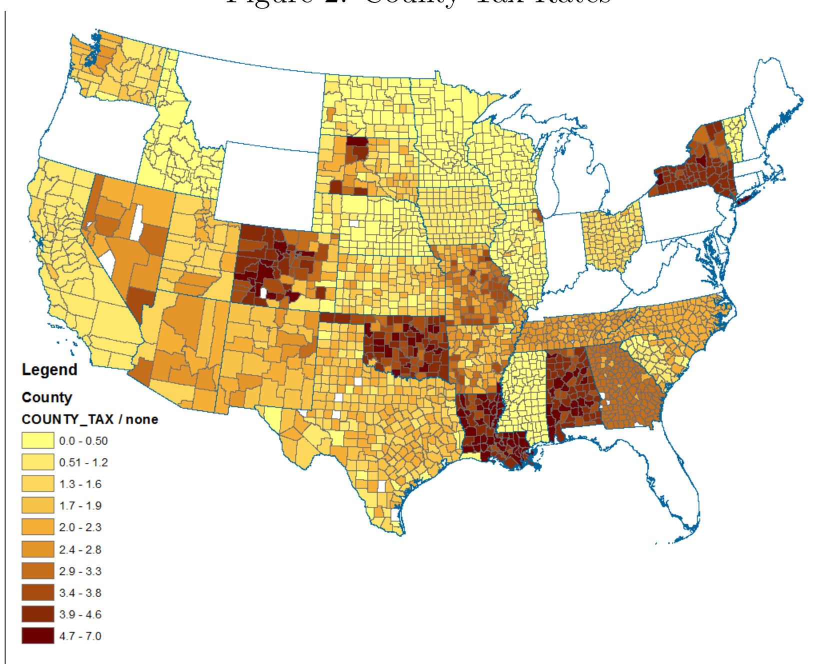


Figure 3: Percent of Population With Access to 4 or More Providers

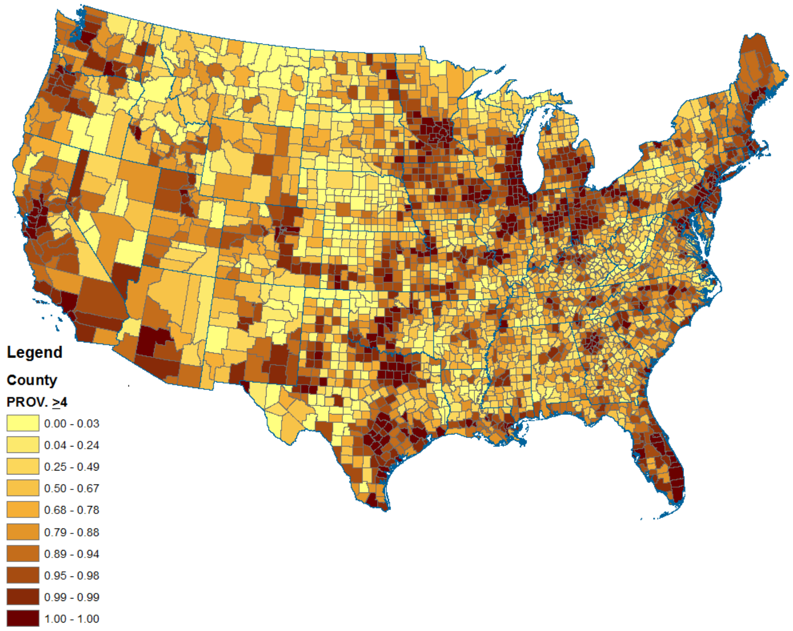
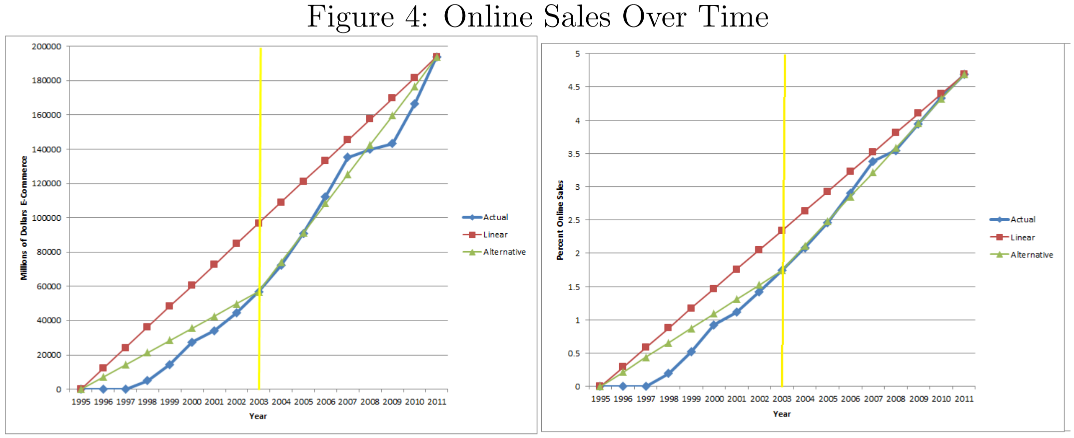
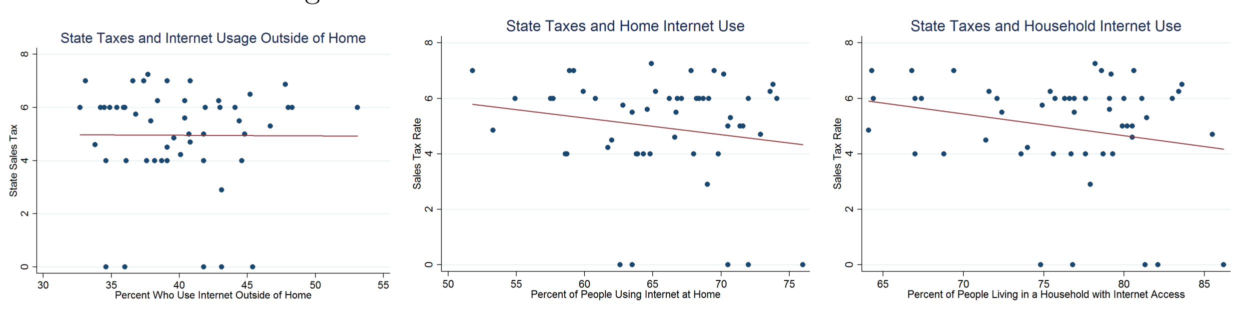


Figure 4: Online Sales Over Time



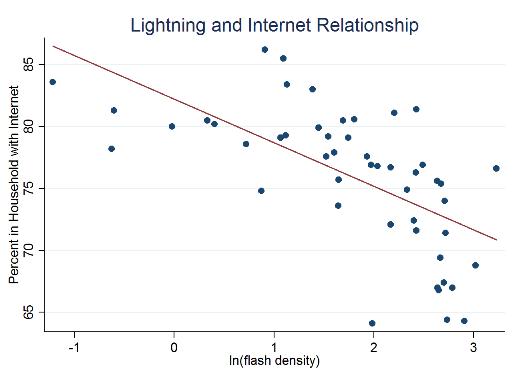
Based on data from the Annual Retail Trade Survey. Units are in millions of dollars and percent of total sales.

Figure 5: State Internet Use and Tax Correlations



Each graph corresponds to one of the questions: "Do you or any member of this household access the Internet at any location outside the home?", "At home, do you access the Internet?", and "At home, do you or any member of this household access the Internet?".

Figure 6: Correlation: Lightning Instrument and Internet Use



The graph shows the relationship between the response to the CPS question "At home, do you or any member of this household access the Internet?" and the log of the lightning flash density at the state level.

Table 1: Summary Statistics

Averages with Standard Deviations in ( )

Variable	Census Place	County Level
Municipal Tax Rate	.77	.81
	(1.15)	(1.08)
County Tax Rate	1.07	1.14
	(1.15)	(1.14)
% of Pop: Any Internet Technology	.99	.98
	(.06)	(.05)
% of Pop: Any Wired Technology	.91	.84
	(.24)	(.15)
% of Pop: Providers ≥ 4	.71	.67
	(.43)	(.35)
% of Pop: Download Speed Greater than 3000k	.98	.96
	(.13)	(.09)
Number of Neighbors	1.81	6.97
	(1.86)	(1.28)
Area	5.60	102
	(17.65)	(139)
Perimeter	14.41	148
	(24.06)	(83.66)
Population	9615	93,196
	(85,836)	(339,842)
Senior (%)	15.90	15.61
	(7.97)	(4.17)
Less Than College (%)	81.65	81.47
	(14.37)	(8.06)
Work in State (%)	96.01	96.04
	(9.03)	(6.99)
Male (%)	49.06	49.93
	(5.34)	(2.25)
Ratio of Private to Public School Students	.13	.11
	(.54)	(.07)
Public Assistance (%)	2.42	2.16
	(3.44)	(1.34)
Non-Citizen (%)	3.01	3.04
	(5.66)	(3.81)
White (%)	84.41	83.89
	(20.32)	(15.60)
Mean Income	57,090	55,728
	(31913)	(12,125)
Median Age	39.24	39.67
	(7.91)	(4.84)
Obama Vote Share	44.00	40.01
	(13.68)	(13.87)
Number of Rooms in Home	5.59	5.54
	(.74)	(.42)
Average Age of Home	39.24	38.35
	(7.91)	(11.58)
Density	1208	174
	(1472)	(1601)
% Agriculture	4.57	7.36
	(7.45)	(7.42)
Sample Size	14,459	2086

Averages are for the towns and counties within states that allow for local taxes only.

Table 2: Regression of Usage on Penetration

Standard Errors in ( ) and R^2 in [ ].

Each cell represents the coefficient on the listed variables from a **separate** regression.

	(1)	(2)
Any Service	.19	.21
	(.56)	(.24)
	[.002]	[.733]
Speed $\geqslant$ 768k	.03	.22
	(.25)	(.24)
	[.001]	[.733]
Speed $\geqslant$ 3000k	.03	.19
	(.25)	(.14)
	[.001]	[.738]
Providers$\geqslant$ 1	-.37	.10
	(.44)	(.28)
	[.006]	[.731]
Providers $\geqslant$ 2	.23	.10
	(.32)	(.14)
	[.01]	[.732]
Providers $\geqslant$ 3	.41**	.13
	(.17)	(.11)
	[.12]	[.739]
Providers $\geqslant$ 4	.28***	.14*
	(.08)	(.08)
	[.20]	[.752]
Providers $\geqslant$ 5	.16***	.08*
	(.06)	(.05)
	[.17]	[.752]
Providers $\geqslant$ 6	.28***	.04
	(.08)	(.02)
	[.14]	[.744]
N	51	51
Unit of Analysis	State	State
Demographic Controls	N	Y
R^2 with no Internet variables	-	.730

Each cell represents a different regression. Each row reports the coefficient on the variable of interest, the standard error and the R^2 from a state-based **univariate** regression of the form $I_i^* = \theta + \delta I_i + \nu_i$ with robust standard errors. The dependent variable is the fraction of homes in a state with Internet access at home. The variable of interest is represented by the variable listed in the row. ***99%, **95%, *90%

Table 3: The Effect of the Internet on Tax Levels

	(1)	(2)	(2')	(3)	(4)	(4')
		OLS			Fractional Response	
Multiple Providers (I)	.094	-.050**	-.018	.096	-.058**	-.018
	(.084)	(.022)	(.017)	(.085)	(.022)	(.023)
N	14,459	14,459	14,459	14,459	14,459	14,459
R^2	.004	.814	.641	.004	.816	.696
Dependent Variable	Town + County	Town + County	Town	Town + County	Town + County	Town
Controls	N	Y	Y	N	Y	Y
State Fixed Effects	N	Y	Y	N	Y	Y

The data used in this table ares at the town level. The dependent variable in columns without a prime is the city tax rate plus county tax rate; in columns with a prime it is only the city tax rate. The measure of Internet penetration is the percent of the population with access to four or more providers. Column (1) presents the results of equation 9 without any controls and (2) presents the results controlling for state fixed effects and town characteristics. Column (3) and (4) present the mean derivatives (marginal effect) from a fractional response model where column (3) has no controls and column (4) controls for town characteristics and fixed effects. All magnitudes are scaled to be interpreted as the percentage point increase in the tax rate given a change in Internet penetration from zero to one hundred percent; Dividing by 100 will yield the effect of a one percentage point increase in Internet penetration on the tax rate. Standard errors are robust to heteroskedasticity. When using the total local tax rate, standard errors are clustered at the county level. The Delta Method is used to calculate standard errors in the fractional response model. ***99%, **95%, *90%

Table 4: Heterogeneity in the Response to the Internet

	(1)	(2)	(1')	(2')
	Total Local Rate Rate		Town Tax Rate	
Multiple Providers (I)	-.091***	-.034	-.075**	-.012
	(.033)	(.022)	(.029)	(.018)
N	7231	7228	7231	7228
R^2	.836	.651	.787	.607
Jurisdiction Size	Large	Small	Large	Small
Controls	Y	Y	Y	Y
State Fixed Effects	Y	Y	Y	Y

All columns are the result of a fractional response model. The data used in this table ares at the town level. The dependent variable in columns without a prime is the city tax rate plus county tax rate; in columns with a prime it is only the city tax rate. The measure of Internet penetration is the percent of the population with access to four or more providers. Column (1) presents the results of equation 9 without any controls and (2) presents the results controlling for state fixed effects and town characteristics. Column (3) and (4) present the mean derivatives (marginal effect) from a fractional response model where column (3) has no controls and column (4) controls for town characteristics and fixed effects. All magnitudes are scaled to be interpreted as the percentage point increase in the tax rate given a change in Internet penetration from zero to one hundred percent; Dividing by 100 will yield the effect of a one percentage point increase in Internet penetration on the tax rate. Standard errors are robust to heteroskedasticity. When using the total local tax rate, standard errors are clustered at the county level. The Delta Method is used to calculate standard errors in the fractional response model. ***99%, **95%, *90%

Table 5: Response in High and Low States

	(1)	(2)	(2')	(3)	(4)	(5)
Marginal Effect: Low-Tax State	-.072**	-.069**	-.080***	-.071**	-.204**	-.012
	(.029)	(.029)	(.030)	(.029)	(.046)	(.035)
Marginal Effect: High-Tax State	-.007	-.008	-.030	-.004	-.006	.006
	(.012)	(.020)	(.020)	(.020)	(.037)	(.020)
N	9792	9792	9792	9792	4707	5085
Tax Rate	Town	Town	Total	Town	Town	Town
Jurisdiction Size	All	All	All	All	Large	Small
Restriction / Addition	$\delta_k = \rho_k = \lambda_k = 0$	None	None	Interact w/ Differential	None	None
Controls	Y	Y	Y	Y	Y	Y
State Fixed Effects	Y	Y	Y	Y	Y	Y

All columns are the result of a fractional response model. The dependent variable in all columns without a prime is the city tax rate; in columns with a prime it is the city plus county tax rate. The measure of Internet penetration is the percent of the population with access to four or more providers. The sample is restricted to towns within one hundred minutes of a border to reduce the need for an extremely flexible function of distance; towns near same tax borders are also excluded. Column (1) presents the results of equation 9 where I restrict all the coefficients on the distance terms to be equal to zero. In column (2) I present results for equation 11 in the text, while (2') studies the total local rate. Column (3) interacts any term in the specification containing an I_i with the size of the tax differential at the state border. Columns (4) and (5) estimate 11 for the sample split at the median population size (note: I use the median for the full sample to compare to previous tables). All estimates are the marginal effect conditional on the side of the border. All magnitudes are scaled to be interpreted as the percentage point increase in the tax rate given a change in Internet penetration from zero to one hundred percent; dividing by 100 will yield the effect of a one percentage point increase in Internet penetration on the tax rate. Standard errors are robust to heteroskedasticity. The Delta Method is used to calculate standard errors in the fractional response model. ***99%, **95%, *90%

Table 6: The Effect By Distance and Tax Differential

Panel A: Distance

	Large Towns		Small Towns	
	Low Side	High Side	Low Side	High Side
At the border	-.458***	-.178**	-.070	-.079
(0)	(.116)	(.083)	(.152)	(.085)
10 minutes	-.247***	-.028	-.018	.001
	(.067)	(.054)	(.069)	(.042)
20 minutes	-.141**	.058	.005	.041
	(.065)	(.051)	(.054)	(.029)
50 minutes	-.225**	.024	.004	-.029
	(.058)	(.043)	(.056)	(.068)
90 minutes	-.193**	-.058	-.029	-.041
	(.075)	(.052)	(.068)	(.033)

Each column presents the mean derivative from column (4) and (5) of the previous table at various distances from the border. Each row evaluates the mean derivative of the distance function at values of 0, 10, 20, 50 and 90 minutes from the border. The standard errors are calculated using the delta method. ***99%, **95%, *90%

Panel B: Tax Differentials

	Large Towns		
	Low Side	High Side	Difference
Nearly Same (0)	.155	.073	.082
	(.083)	(.046)	
1 percentage point	-.032	.031	-.063
	(.054)	(.039)	
3 percentage points	-.318***	-.043	-.275
	(.046)	(.037)	
5 percentage points	-.483***	-.105**	-.378
	(.051)	(.041)	

Each column presents the mean derivative from column (4) and (5) of the previous table at various tax differentials at the state border. Each row evaluates the mean derivative at values of the tax differential at 0.5, 1, 3, and 5 percentage point differentials. When the differential is zero, it reduces to -.139 from the table above. The standard errors are calculated using the delta method. ***99%, **95%, *90%

Table 7: The Effect of the Internet on Tax Rates Using Lubotsky and Wittenberg (2006)

	(1)	(2)	(3)	(4)	(5)	(6)
Marginal Effect LW-Index:	-.159***	-.122***	-.180***	-.102***	-	-
p^{ρ}	(.027)	(.018)	(.030)	(.022)		
(Full Sample)						
Low Tax State					-.366***	-.135***
					(.058)	(.038)
High Tax State					-.088**	-.053***
					(.041)	(.018)
N	14,459	14,459	7231	7228	7231	7228
R^2	.820	.643	.708	.591	.703	.600
Dependent Variable	Town + County	Town	Town	Town	Town	Town
Sample	All	All	Large	Small	Large	Small

The data used in this table are at the town level. The dependent variable is given for each column and the measure of Internet penetration is constructed using the Lubotsky and Wittenberg (2006) method. The variables used in the analysis include percent of town with access to 0, 1, 2, 3, 4, 5, or more than 6 providers, percent with access to any technology, with access to wireless technology, and with access to download speeds greater than 1500k and greater than 3000k. Column (1) and (2) presents the comparable results to Table 3 column 2 and 2', respectively. Columns (3) and (4) are comparable to Table 4 column 1' and 2'. Columns (5) and (6) are comparable to Table 5 columns 4 and 5, respectively. All columns include demographic controls and state fixed effects and are estimated using a linear framework. If applying this procedure to the non-linear fractional response method, for example, I get a result of -.165*** for column 1; and the results for all other columns are comparable. ***99%, **95%, *90%

Table 8: The Effect of the Internet on Tax Rates Using Lightning Strikes as an IV (Andersen et al. 2012)

	(1)	(2)
First Stage	-.233***	-.233***
	(.110)	(.110)
Second Stage Marginal	-.105**	-.127***
Effect	(.055)	(.043)
Tax Rate	Town + County	Town

This table presents the IV results. The first row represents the reduced form first stage coefficient on the instrument. The second row is the second stage marginal effect from a fractional response model. Column (1) uses the total tax rate as the dependent variable; column (2) used the town tax rate as the dependent variable. I instrument for the Internet penetration index using the flash density of lightning strikes in an area. ***99%, **95%, *90%

7 Appendix

7.1 Derivation of the Nash Equilibrium

7.1.1 No Online Shopping

The revenue functions for the town in the high-tax state and the low-tax state are

$$R_H = t_H(1 - \frac{b + t_H - t_L}{d}),\ R_L = t_L(1 + \frac{b + t_H - t_L}{d}). \tag{17}$$

Differentiating with respect to each town's tax rate yields the best response functions

$$t_H = \frac{1}{2}(d - b) + \frac{t_L}{2},\ t_L = \frac{1}{2}(d + b) + \frac{t_H}{2} \tag{18}$$

and where after solving the second equation for t_H, it can easily be seen that a Nash equilibrium will exist if d is sufficiently large; I maintain this assumption in the following cases to guarantee positive tax rates.[27] Algebra yields the equilibrium

$$t_H^N = d - \frac{b}{3},\ t_L^N = d + \frac{b}{3}. \tag{19}$$

7.1.2 The Internet as a Tax Haven

The revenue functions are now

$$R_H = t_H(1 - \frac{b + t_H - t_L}{d}) - \frac{\theta}{2}t_H(t_H + T_H),\ R_L = t_L(1 + \frac{b + t_H - t_L}{d}) - \frac{\theta}{2}t_L(t_L + T_L). \tag{20}$$

The best response functions are obtained as

$$t_H = \frac{(2d - 2b - d\theta T_H)}{4 + 2d\theta} + \frac{2t_L}{4 + 2d\theta},\ t_L = \frac{(2d + 2b - d\theta T_L)}{(4 + 2d\theta)} + \frac{2t_H}{4 + 2d\theta} \tag{21}$$

Algebra yields the equilibrium

$$t_H^I = \frac{d(6 - 4T_H\theta + T_L\theta) + d^2\theta(2 - T_H\theta) - 2b}{2(1 + d\theta)(3 + d\theta)},\ t_L^I = \frac{d(6 + T_H\theta - 4T_L\theta) + d^2\theta(2 - T_L\theta) + 2b}{2(1 + d\theta)(3 + d\theta)}. \tag{22}$$

The tax rates are guaranteed to be positive given the specification of the parameters and it is easy to check that even with the revenue leakage, the revenue functions evaluated at the Nash equilibrium are also positive.

[27] This condition arises because towns cannot be composed of all cross-border shoppers. In the model of Agrawal (2012) existence is guaranteed by assuming towns are sufficiently long in length; conditions on d are equivalent to this.

7.1.3 The Internet as an Anti-Haven

The revenue functions are given by

$$R_H = t_H(1 - (1-\theta)\frac{b + t_H - t_L}{d}),\ R_L == t_L(1 + (1-\theta)\frac{b + t_H - t_L}{d}). \tag{23}$$

The best response functions are obtained as

$$t_H = \frac{d}{2(1-\theta)} + \frac{t_L}{2},\ t_L = \frac{d}{2(1-\theta)} + \frac{t_H}{2} \tag{24}$$

Algebra yields the equilibrium

$$t_H^A = \frac{d}{1-\theta} - \frac{b}{3},\ t_L^A = \frac{d}{1-\theta} + \frac{b}{3} \tag{25}$$

and where as θ approaches one, the border closes and the tax rates are set to extract all the surplus from the consumers.

7.2 Proofs of Propositions

7.2.1 Proof of Proposition 1

Differentiating the Nash equilibrium tax rates given by 22 with respect to the Internet parameter yields:

$$\frac{\partial t_L^I}{\partial \theta} = -\frac{d(5T_H + 4T_L + 2d^3\theta^2 + d^2\theta(12 + T_H\theta) + 2d(9 + 2T_H\theta + T_L\theta))}{2(3 + 4d\theta + d^2\theta^2)^2} < 0 \tag{26}$$

and

$$\frac{\partial t_H^I}{\partial \theta} = -\frac{d(4T_H + 5T_L + 2d^3\theta^2 + d^2\theta(12 + T_L\theta) + 2d(9 + T_H\theta + 2T_L\theta))}{2(3 + 4d\theta + d^2\theta^2)^2} < 0 \tag{27}$$

which demonstrates that tax rates fall as Internet access increases. The question is then whether taxes fall by more in the low or high-tax state. Tedious algebra then yields a variant of the equation in the text:

$$\left|\frac{\partial t_L^I}{\partial \theta}\right| - \left|\frac{\partial t_H^I}{\partial \theta}\right| = \frac{db}{2(3 + d\theta)^2} \geq 0. \tag{28}$$

This demonstrates that taxes fall by more in the low-tax state.

7.2.2 Proof of Proposition 2

Differentiating the Nash equilibrium given by 25 yields

$$\frac{\partial t_L^I}{\partial \theta} = \frac{\partial t_H^I}{\partial \theta} = \frac{d}{(1-\theta)^2} > 0 \tag{29}$$

and where it is obvious that $\frac{\partial t_L^I}{\partial \theta} - \frac{\partial t_H^I}{\partial \theta} = 0$.

7.3 Data

Because I combine the tax data with Census data, I restrict the sample to municipalities that are identified Census Places.[28] To do this, I name merge geo-coded data provided by the 2010 American Community Survey (ACS) to the tax data. The sales tax data used in this paper and the process of merging the tax data to Census places are described in detail in Agrawal (2012); the only difference is that I use a cross-section from 2011 rather than 2010.[29] Because I have merged the the jurisdictions in the tax data file to Census places, I also have access to any data in the 2010 ACS. Using the geo-spatial data constructed in Agrawal (2012), I also have calculated the driving time to the nearest state border. Distance to the border is the time (in minutes) that minimizes the driving time from the population weighted centroid of a town to the closest state border and a major road intersection; by using minutes rather than miles, I am able to capture the true cost of driving to the border. I identify low-tax borders as those borders that have a lower state tax rate in the nearest neighboring state; a high-tax border is a border that has a higher state sales tax rate in the nearest neighboring state.

7.4 Maps

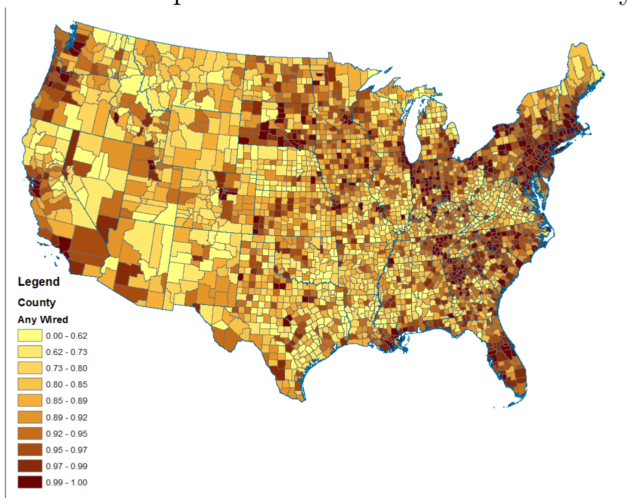
With regard to the spatial distribution of wireless and wireline access, each shade represents various percentiles. On the wireline map, each color shade represents 10% of the data. On the wireless map, each shade represents 20% of the data. One thing that is immediately evident from these figures is that almost all places in the country have a majority of the population with access to one of these technologies. In fact, more than 50% of counties have greater than 90% penetration rates. Because wireless and wireline penetration have little

[28] A Census Place is generally an incorporated place with an active government and definite geographic boundaries such as a city, town, or village. In some western states, a Census Place may be an unincorporated place that has no definite boundaries or government. Census Places contain some locations that may not have legal authority or jurisdiction to set sales taxes.

[29] Although I do have panel data on local sales tax rates, the Internet penetration data described below dates only to 2011. I will, however, exploit 2003 to 20011 tax rate changes.

variation, it is likely to be of little use with regard to the actual usage of Internet within jurisdictions, which is what a competitive government likely cares about. Figures 7 and 8 show the variation.

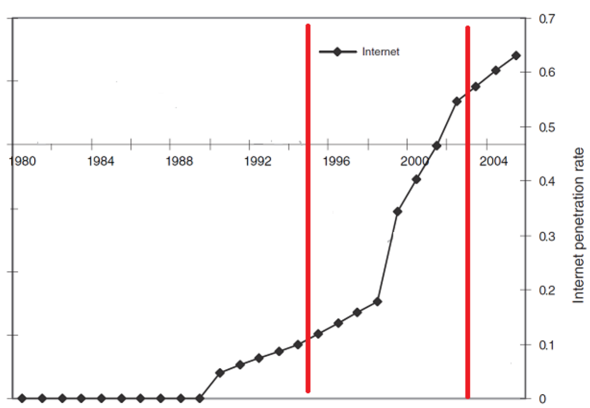
Figure 7: Percent of Population With Wireline Access by Percentile



7.5 Goolsbee, Lovenheim and Slemrod (2010)

Figure 9 shows that between 1995 and 2003, growth in Internet penetration was approximately linear.

Figure 9: Interpolation from Goolsbee, Lovenheim and Slemrod (2010)



7.6 Other Measures of Internet Use

The results in Table 2 comparing CPS data with measures of broadband penetration suggested that four different measures of Internet penetration have an R^2 greater than .10. In

Figure 8: Percent of Population With Wireless Access by Percentile

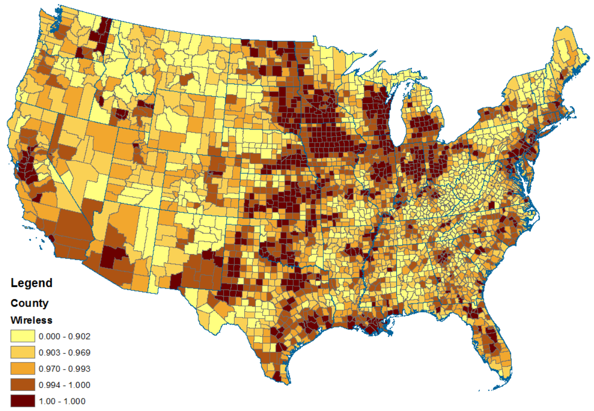


Table [TBA] I show that the baseline results are robust to using most of these measures as the proxy variable. More detailed specifications reported in the text are also robust. This suggests that the signs are consistent across the set of possible proxy variables. Of course, using the Lubotsky and Wittenberg (2006) is the preferred method of verifying this because it encompasses multiple variables simultaneously and can say something about the magnitude of the coefficients in the presence of measurement error concerns.

7.7 Testing For Internet Differences at Borders

Showing the response of municipalities is asymmetric on the high-tax and low-tax side of borders is more convincing if it can be shown that the Internet penetration rates do not vary based on the side of the border conditional on other explanatory variables. To test this, I implement a fractional response model, for the sub-sample of municipalities not bordering a same-tax border:

$$E(I_i|\cdot) = G(\alpha + \beta H_i + \sum_{k=1}^{3} \delta_k H_i (d_i)^k + \sum_{k=1}^{3} \lambda_k (d_i)^k + \zeta + \sum_{m} X_{im}\gamma_m) \tag{30}$$

where all variables are as defined in the text, distance is the driving time to the border and ζ are state fixed effects or border pair fixed effects, so that I am using variation in Internet penetration within a state or within the region of a particular border crossing. I estimate this using a fractional response model given that Internet penetration rates are between 0 and 1 with mass points at both extremes. The results in table 9 indicate that there is no significant difference in Internet penetration depending on the side of the border in a local region of the border.

Table 9: Testing For Discontinuities at Borders

	(1)	(2)	(3)
Effect of Switching (Low to High)	-.038	.058*	-.029
	(.033)	(.036)	(.037)
R^2	.357	.377	.404
Border Fixed Effects	N	Y	Y
State Fixed Effects	Y	N	Y

This table presents the results of equation 30. Columns (1) and (2) include a distance interaction, while column (3) does not. ***99%, **95%, *90%

7.8 Lubotsky and Wittenberg (2006)

Table [TBA] shows that the results of the procedure are robust to using various subsets of the proxy variables.