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

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Research Focus

- *This paper will study the tax setting behavior of jurisdictions in the "new economy." Does Internet access cause cities and towns to raise or lower their sales tax rates?*
  - 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.

Background: Online Sales

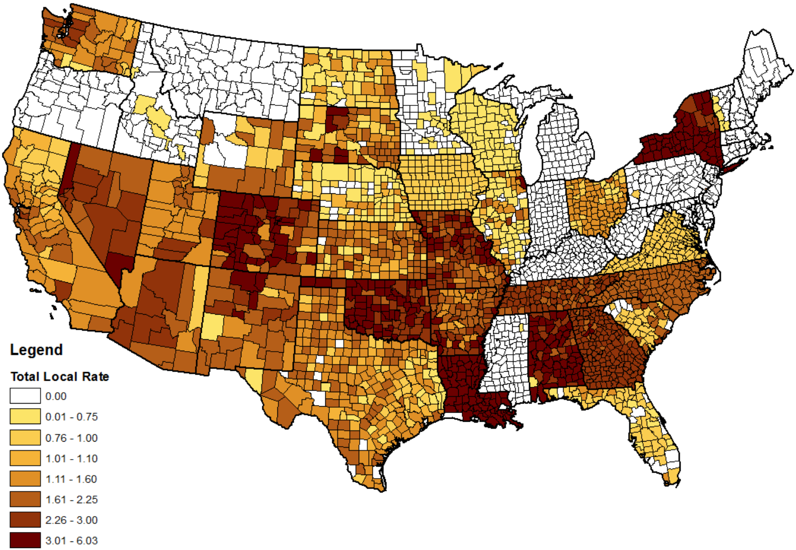
- In 2011, consumers spent approximately 200 billion dollars on online purchases (4 trillion retail sales total).
  - Of these purchases, approximately, 11% occurred on eBay and approximately 13-19% occurred on Amazon.
- In addition, just over 3 trillion dollars of online purchases from business to business sales.
  - Of these purchases, it has been estimated that 13% are subject to retail sales tax collection.
  - Compliance studies indicate that tax avoidance occurs on about 25% of these sales.
- Online sales growing rapidly: increasing concern from sub-federal governments.

Background: Online Regulations & Local Taxes

- *Quill Corp. v. North Dakota:* online firms are only required to remit sales taxes from consumers living in a state where the firm has **nexus**.
  - For firms without nexus, the consumer is required to remit the tax to the government, but this is easily evaded.
  - Once a firm has nexus in a state, it has nexus in every locality.
- Local governments and sales taxes: Extremely decentralized.
  - Over 30 states allow local governments to levy sales taxes
  - These local taxes range between 0 and 6%
  - And contribute between 0 and 52% of municipal revenue.

Tax Rates

[State Map]



Summary of Results

Theory: Local taxes...

1. fall if online sales are tax free.
    1. fall moreso in towns with high local taxes.
    2. fall moreso in big (population) towns.
2. rise if online sales are taxable.

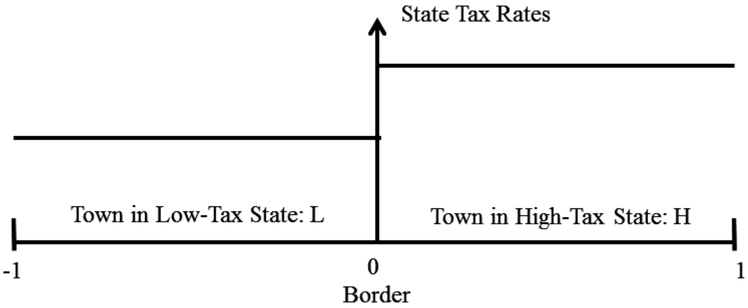
Empirics: What is the Effect?

1. The Internet is a tax haven.
    1. Yes, the effect is 2.5 times as large.
    2. Yes, the effect is 6 times as large.
2. Dominated by (1).

Question: Theory

What are the theoretical effects of e-commerce on local sales tax rates?

Geography of the Model

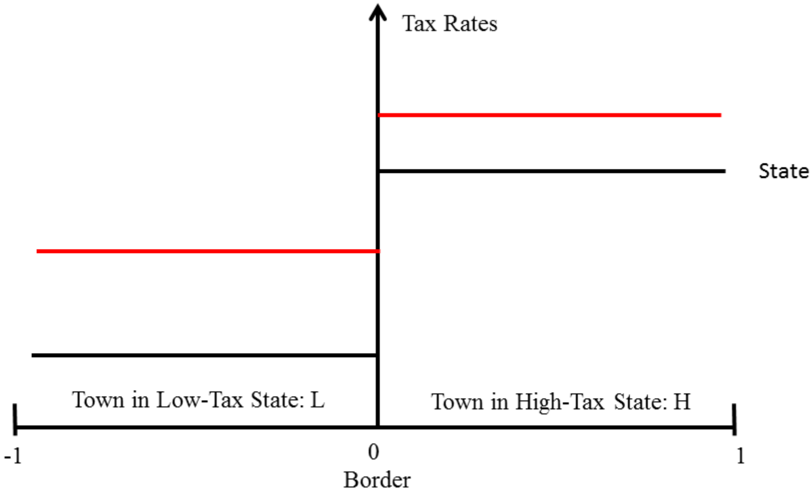


A Standard Tax Competition Model

- Governments: Revenue maximizers as in Nielsen (2001, *SJE*), Kanbur and Keen (1993, *AER*), Agrawal (2015, *AEJ: EP*) model
  - The focus is on two towns that are in **different** states where the state tax rates differ at the border: $T_H - T_L = b > 0$.
  - The towns can set tax rates t_H and t_L on top of the state tax rates
  - Town tax rates are set in a Nash game taking the state rates as parameters
- Consumers: Standard Nielsen (2001, *SJE*) model, variant of Kanbur and Keen (1993, *AER*)
  - Choice is where to buy the good, not how much of the good to buy
  - Purchase the good abroad if the benefit (tax savings) is greater than the cost (transportation)
  - Solution to consumer problem allows me to construct the revenue functions

Solution with No Internet

[Proof]

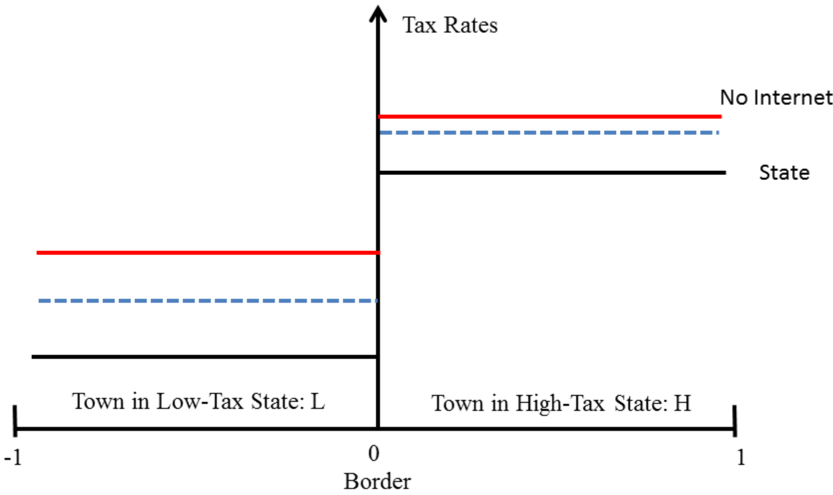


Modeling Tax Free Internet

[Proof]

- Introduce a cost of shopping online, where the cost of shopping online differs at each point on the line-segment (people are heterogeneous in their desire to buy goods online).
  - Implicit assumption: the people who buy online are not in the set of potential cross-border shoppers.
- Consumers (living in the high-tax state) then compare the cost of shopping online with the tax savings (from both buying at home and buying abroad).
- Town taxes fall by more in the low-tax state than the high-tax state and when the tax differential is largest.

Solution with Tax Free Internet



The Role of Jurisdiction Size

[Model with Population]

- If state tax rates were the same, but one town was larger than the other town:
  - Taxes fall by more in the big town.
- Intuition: Tax rates fall moreso in places where the tax base is relatively large (and the tax rate high).
- Agrawal and Wildasin (2015, in progress) shows that the Internet has differential effects depending on agglomeration. Taxes may fall in cities, but rise in small towns.

Solution with Taxable e-Commerce

[Proof]

- Suppose some people buy on taxable websites because of added variety, information, etc.
- Then:
  - For people who previously bought the good in their home town, revenue is unchanged.
  - However, if some cross-border shoppers switch to buying online, tax revenue is now correctly remitted to the town of residence.
  - The more people with preferences to buy online, the lower the Nash competitive pressure in the game and the higher the local tax rates.

Question: Data

Do places with higher Internet penetration set higher or lower local sales taxes?

Outline of Methods

1. Cross-sectional correlations.
2. Border discontinuity design.
    1. Advantage: Can use local variation in tax rates.
    2. Disadvantage: Unobservable changes at borders.
3. Panel data.
    1. Advantage: Internet use changed dramatically from 2003 to 2011.
    2. Disadvantage: Requires aggregation to the state level.

Data

- Data on Internet penetration comes from the national broadband map and provides me with data at the Census Place, county, and state level (earliest wave: 2011).
  - Any Internet provider; Any wired provider; Any wireless provider
  - A particular type of Internet provider (cable, DSL, etc)
  - More than one (2, 3, etc) provider
- Local sales tax data on every town, county, state, and sub-municipal district in the country.
- Geographic proximity data.
  - I calculate the minimum time needed to drive from the population weighted centroid of every town to the nearest state border major road crossing.

Internet Usage

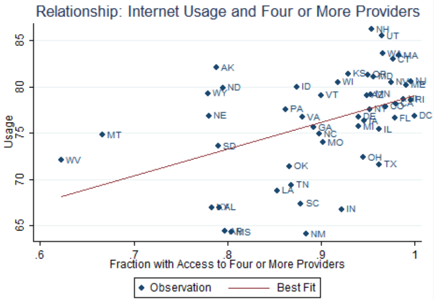
- What is observable to the researcher is the percent of people with *potential* access to the Internet, but local officials may care about *usage* (perhaps only usage for online shopping).
- Which of the Internet penetration rates is the "best" proxy for Internet usage?
  - Alternative: Index creation method using Lubotsky and Wittenberg's procedure designed to minimize attenuation bias.
- Internet usage is available from the CPS 2010 at STATE level.
  - "At home, do you or any member of this household access the Internet?"
  - Also use per capita eBay sales.

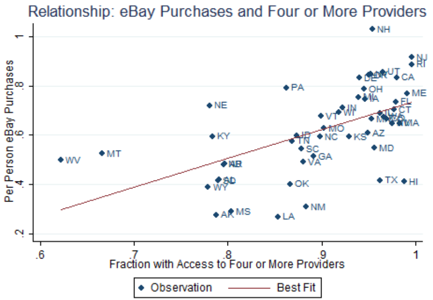
Internet Usage

	Any Service	Wireless Service	Provider $\geqslant$ 1	Provider $\geqslant$ 2	Provider $\geqslant$ 3	Provider $\geqslant$ 4	Provider $\geqslant$ 5
Coefficient	.19	.15	-.37	.23	.41**	.28***	.16***
SE	(.56)	(.16)	(.44)	(.32)	(.17)	(.08)	(.06)
R^2	[.002]	[.01]	[.006]	[.01]	[.12]	[.20]	[.17]

$$I_i^* = \lambda + \delta I_i + \nu_i$$

Internet Usage





Discussion

- Even after controlling for demographics, number of providers still explains variation in usage at the state level (especially in the eBay variable).
- Reasons for validity:
  - Theoretical IO: Faulhaber and Hogendorn (2000) shows that "the sub-game equilibrium capacity... strategies depend only on the number of networks to which a household has access."
  - Empirical IO: Disataso et al. (2006) verifies that inter-platform competition such as DSL versus cable technologies (rather than intra-platform competition), increase Internet usage.
  - Empirical IO: 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.
  - FCC Reports: Indicate competition encourages Internet usage.

Summary Stats

	Town
Town Tax	.771
	(1.158)
Any Tech	.994
	(.058)
$\geq$3 providers	.879
	(.302)
$\geq$4 providers	.706
	(.430)
N	14,459

Cross-sectional Specification

- I will present results of the baseline specification using a fractional response model (Papke and Wooldridge 1996 *JAE*, Papke and Wooldridge 2008 *JE*, Wooldridge 2014 *JE*):

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

- In the fractional response model, $0 \leq \tau_i \leq 1$ where the extreme values can occur with positive probability.
- Why fractional response model? Zeros in the sample of tax rates. However, OLS/Tobit results similar. [OLS Results]
- SE's clustered at county level.

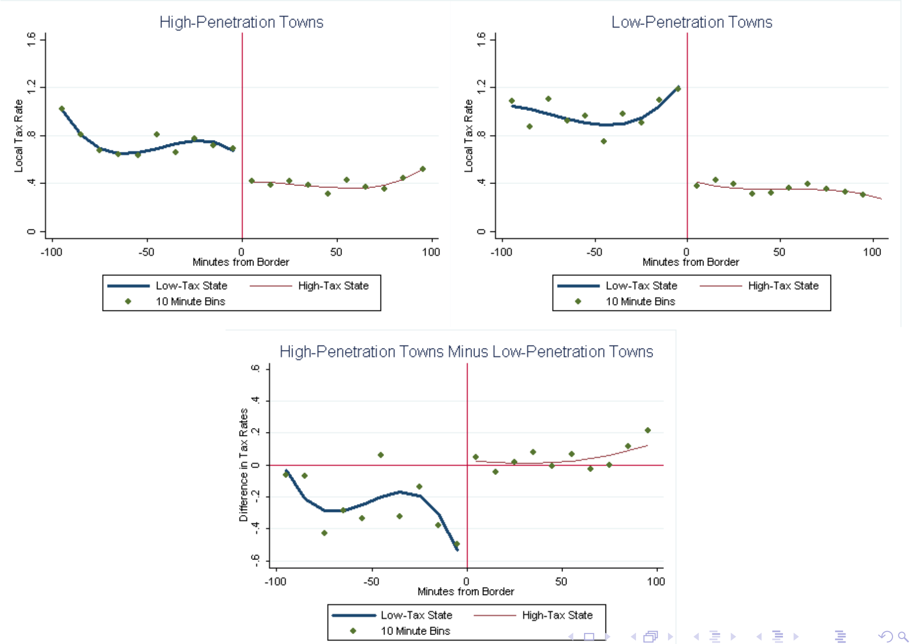
The Role of Jurisdiction Size / Baseline Magnitudes

	(1)	(2)	(1')	(2')	(3)
	Split at Median		Split at Mean		Weighted
Multiple Providers (I)	-.075** (.038)	-.012 (.021)	-.314** (.134)	-.033 (.021)	-.315*** (.093)
N	7231	7228	2198	12,261	14,459
Jurisdiction Size	Above Median (~1500)	Below Median (~1500)	Above Mean (~10,000)	Below Mean (~10,000)	All
Controls	Y	Y	Y	Y	Y
State Fixed Effects	Y	Y	Y	Y	Y

Overcoming the Threats to Identification in a Cross-Section

- I exploit a borders-based RD approach.
  - The goal is to compare similar towns that have effectively different treatments of the Internet (towns in low-tax states are more intensely treated than towns in high-tax states).
  - Helps identification because I can now test for differences in observables and provides me with a test of heterogeneity.
  - The differences in the two effects represents a lower bound to the true treatment effect given that towns in both states are treated.
- The border RD strategy is designed to deal with the problem that unobserved heterogeneity can be correlated both with local tax rates and Internet penetration.
- The threat to identification is similar to that of the standard RD design – with respect to unobservables changing discontinuously at the border that are also correlated with Internet penetration effectiveness.

Visual Evidence



Specification: Borders

$$E(\tau_i|\cdot) = G(\alpha_0 + \alpha_1 H_i + \beta_0 I_i + \beta_1 I_i H_i + \sum_{k=1}^{K} \delta_k (d_i)^k + \sum_{k=1}^{K} \varphi_k H_i (d_i)^k + \sum_{k=1}^{K} \rho_k I_i (d_i)^k + \sum_{k=1}^{K} \lambda_k I_i H_i (d_i)^k \zeta + \sum_m X_{im} \gamma_m)$$

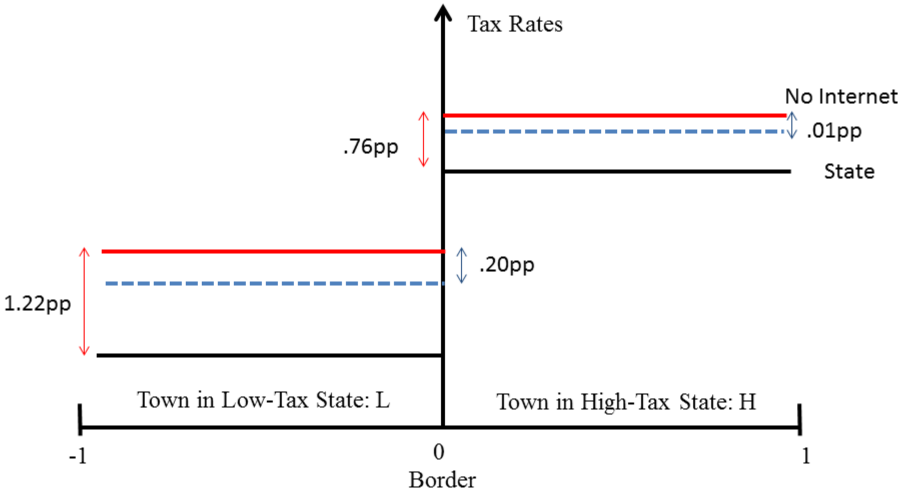
- Polynomial order selected using leave-one-out cross validation.
- In the paper, I show that most observable characteristics are balanced at borders. (Including I.) [Balancing Test]
- Mean derivatives are calculated as:

$$\hat{E} \frac{\partial G(\cdot|d_i = 0)}{\partial I_i} = \begin{cases} \frac{1}{N_0} \sum_i \hat{\beta}_0 G'(\cdot) & \text{if } H_i = 0 \\ \frac{1}{N_1} \sum_i (\hat{\beta}_0 + \hat{\beta}_1) G'(\cdot) & \text{if } H_i = 1 \end{cases}$$

Results: Towns by Type of State Border

	(OLS)	(1) FR	(2) FR	(3) FR
Marginal Effect: Low-Tax State	-.161***	-.067*	-.204***	-.011
	(.051)	(.040)	(.063)	(.041)
Marginal Effect: High-Tax State	-.015	-.004	-.006	.004
	(.042)	(.030)	(.042)	(.024)
N	9792	9792	4707	5085
Tax Rate	Town	Town	Town	Town
Jurisdiction Size	All	All	Large	Small
Controls	Y	Y	Y	Y
State Fixed Effects	Y	Y	Y	Y

Effects Not Conditional on Distance (for Large Towns)

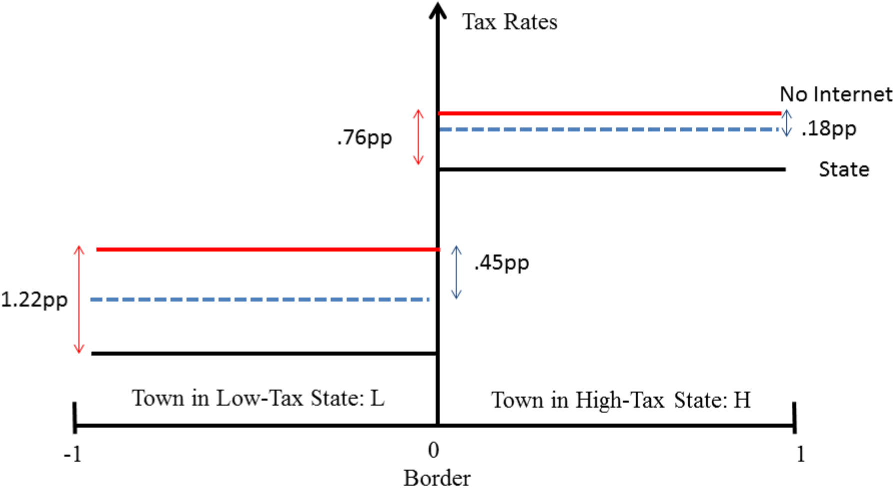


Results as $d \to 0$ and By Differentials

Panel A: Distance		
	Large Towns	
	Low Side	High Side
At the border	-.458***	-.175
(0)	(.151)	(.163)
10 minutes	-.215**	-.074
	(.091)	(.085)
20 minutes	-.105	.004
	(.093)	(.073)
50 minutes	-.250***	.063
	(.087)	(.059)
90 minutes	-.203*	-.072
	(.104)	(.085)

Panel B: Tax Differentials		
	Large Towns	
	Low Side	High Side
Nearly Same (0)	.025	.004
	(.136)	(.080)
1 percentage point	-.093	.008
	(.072)	(.053)
3 percentage points	-.246***	.013
	(.072)	(.052)
5 percentage points	-.320***	.017
	(.101)	(.093)

Effects at the Border



Results: Border-Pair vs. State Fixed Effects

	(1)	(2)	(3)
Marginal Effect: Low-Tax State	-.458***	-.733***	-.369**
	(.151)	(.178)	(.149)
Marginal Effect: High-Tax	-.175	-.280	-.075
State	(.163)	(.282)	(.157)
N	9792	9792	9792
Tax Rate	Town	Town	Town
FEs?	State	Border-Pair	State & Border-Pair

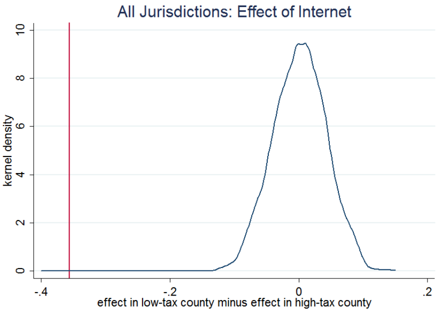
Ruling Out "Border" Effects Unrelated to the Internet

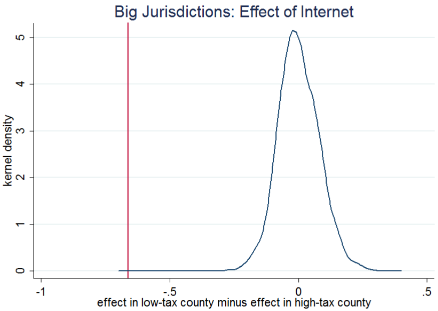
- I conduct a placebo test by using county borders.
  - The results of the theory can be generalized where "states" are "counties" and towns are now within these counties.
- Advantage of county borders: there are many county borders with no county tax rate differentials.
- I split the sample to borders (w) with county tax differentials and (w/o) without county tax differentials.
  - Sample (w) used to estimate the previous model.
  - Sample (w/o) used to randomly assign a side of the border as "high" and "low".

Results: County Borders

	(1)	(2)
Low-Tax County	-.168**	-.416****
	(.069)	(.100)
High-Tax County	.188***	.246***
	(.054)	(.086)
N	5792	3155
Dependent Variable	Town	Town
Sample	All Towns	Large Towns
Borders Used	County Borders Not State Borders	County Borders Not State Borders

Placebo Tests





The Role of Nexus

- Expect that the anti-haven effect will be largest in states that have a large number of firms with nexus $\Longrightarrow$ more taxable online sales.
- Data on nexus status is not readily available.
- Bruce, Fox, and Luna (2014) collect nexus data by visiting approximately 200 e-tail websites and make purchases using a zip code from every state. The authors record if taxes are due.
- Bruce, Fox, and Luna (2014) provide me with data that separates the states into four quartiles on the basis of the number of firms with nexus.

The Role of Nexus

	(1)	(2)	(2')
Marginal Effect: Low-Tax State & Low Nexus State	-.366***	-.328***	-.061
	(.075)	(.059)	(.043)
Marginal Effect: Low-Tax State & High Nexus State	-.027	.244	.157***
	(.060)	(.157)	(.038)
Marginal Effect: High-Tax State & Low Nexus State	-.125**	-.084**	-.014
	(.054)	(.039)	(.024)
Marginal Effect: High-Tax State & High Nexus State	.122**	.259***	.062**
	(.050)	(.078)	(.031)
N	4707	4707	5085
Tax Rate	Town	Town	Town
Jurisdiction Size	Large	Large	Small
Nexus Definition	Above Mean Total Number	Top Quartile Total Number	Top Quartile Total Number

Other Robustness Checks

- Implementing Lubotsky and Wittenberg (2006, *ReStat*) to address measurement error concerns: Results are biased towards zero by at least 50%. [Lubotsky and Wittenberg Results]
- Following Agrawal and Hoyt (2014, wp), use within MSA variation of the 50 MSAs that are split by a state border(s). [Within MSA Results]
- Following Andersen, Bentzen, Dalgaard and Selaya (2012, *ReStat*), use lightning strikes as an instrument for IT usage. [IV Results]

Panel Data

- I have assembled the first ever (in the economics literature) national panel database for all state, county, municipal, and sub-municipal sales tax rates in the country. [Data from 2003 to 2011 at the monthly frequency.]
- FCC Form 477 collects Internet subscription data.
  - Data collection started in 2000. Data are available at the zip code level and starting in 2008 at the county level (however, data are binned into large categories for anonymity reasons).
  - Data are released at the state level (June, December) detailing the fraction of households with an Internet subscription.
- ACS state-level controls available yearly starting in 2006; BLS controls at monthly frequency.

Some Descriptive Statistics on Town Changes: Simple Averages

[Formal Analysis]

	High-Tax State	Low-Tax State
High Penetration	.081	.123
	[-1.5, 2.75]	[-4, 3.5]
Low Penetration	.069	.172
	[-2.75, 2.5]	[-5, 6]

Tax Changes

- The border design relies on the assumption that towns on opposite sides of state borders are, on average, similar in their unobservables.
- I can exploit tax changes over time to identify the effect of the Internet using the Form 477 Data.
    - The Internet likely changed from 2003 to 2011 in a manner that would be very different from the omitted variable threats in the cross-section.

Exploiting Tax Changes and Form 477 Data

- Because Form 477 is only released at the state level, I aggregate local taxes within a state for each month-year that Form 477 is filed.
- This gives me a weighted average of the local tax rates in the state and a measure of the weighted average total tax rate.
- I then estimate:

$$\tau_{s,t} = \alpha + \beta n_{s,t} + \zeta_s + \theta_t + \varepsilon_{s,t}$$

- Results are robust to including controls as well.
- $n_{s,t}$ is subscription (not penetration data). Potential endogeneity due to reverse causality?

Baseline Results: Total Rate

	Total Tax Rate (State + Local)		
	(1)	(2)	(3)
Fraction of Subscriptions ($n_{s,t}$)	-.809**	-.348**	-.497**
	(.350)	(.177)	(.195)
N	855	804	804
Method	FE (OLS)	FD (OLS)	FD (WLS)

- Griliches and Hausman (1986, *JE*) and Ziliak, Wilson and Stone (1999, *ReStat*) show that measurement error will bias the first difference estimators downward (towards zero) by more than they will bias the within estimators.
- Wooldridge (2002)'s test rejects the null hypothesis of no serial correlation – for this reason, present first differences as baseline.
- $sd(n) = 0.18$

Baseline Results: Local Rates

	Average Local Tax Rate	
	(1)	(2)
Fraction of Subscriptions ($n_{s,t}$)	-.261* (.134)	-.291** (.137)
N	804	804
Method	FE (OLS)	FD (WLS)

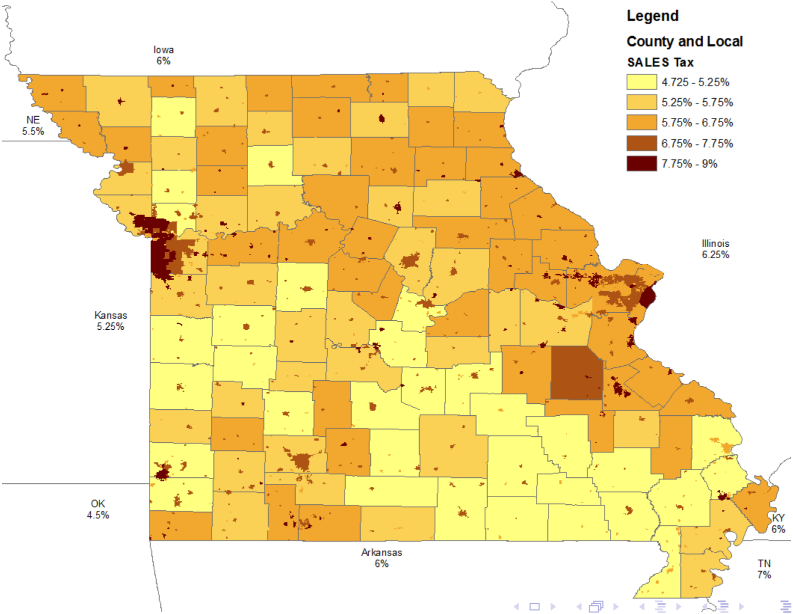
- Very little dynamics.
- Results larger later in the sample.
- Binary choice models.

Summary of Results

- Theoretically, access to e-commerce has offsetting channels: the haven effect vs. anti-haven effect.
- Empirically, access to the Internet puts downward pressure on tax rates for relatively large municipalities and the effect is – as predicted by theory – most pronounced when local tax rates are high.
    - This provides evidence that the presence of tax-free shopping constrains a municipality's ability to raise revenue via rate increases, but only in places not previously constrained by cross-border shopping.
- This negative effect persists in the panel data analysis.

Tax Rates: Town, County, and State Level

[Back]



Proof: No Internet

[Back]

$$R_H = t_H\left(1 - \tfrac{b+t_H-t_L}{d}\right),\ R_L = t_L\left(1 + \tfrac{b+t_H-t_L}{d}\right)$$

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

$$t_H^N = d - \tfrac{b}{3},\ t_L^N = d + \tfrac{b}{3}\ \text{Solution: } t_L^N - t_H^N = \tfrac{2b}{3} \implies t_L^N > t_H^N$$

- Requires d to be sufficiently large for an equilibrium to exist and be unique.

Proof: Tax Free Internet

[Back]

- Let the cost of buying online be $k(1-s)$ and let $\theta \equiv 1/k$.
  - Assumes a mapping between distance to the border and online shopping where the people furthest from the border have the lowest cost of shopping online.
- Consumers select location for shopping that maximizes surplus:
  - $V - 1 - t_L - T_L - ds$ from cross-border shopping
  - $V - 1 - t_H - T_H$ from buying at home
  - $V - 1 - k(1-s)$ from buying online

Proof: Tax Free Internet

[Back]

$$R_H = t_H\left(1 - \frac{b+t_H-t_L}{d}\right) - \theta t_H(t_H + T_H),\; R_L = t_L\left(1 + \frac{b+t_H-t_L}{d}\right) - \theta t_L(t_L + T_L)$$

$$t_H = \frac{d-b-d\theta T_H}{2+2d\theta} + \frac{t_L}{2+2d\theta},\; t_L = \frac{d+b-d\theta T_L}{2+2d\theta} + \frac{t_H}{2+2d\theta}$$

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

$$\frac{\partial t_L^I}{\partial\theta} = -\frac{d(5T_H+4T_L+8d^3\theta^2+4d^2\theta(6+T_H\theta)+2d(9+4T_H\theta+2T_L\theta))}{(3+8d\theta+4d^2\theta^2)^2} < 0$$

$$\frac{\partial t_H^I}{\partial\theta} = -\frac{d(4T_H+5T_L+8d^3\theta^2+4d^2\theta(6+T_L\theta)+2d(9+2T_H\theta+4T_L\theta))}{(3+8d\theta+4d^2\theta^2)^2} < 0$$

Proof: Taxable Internet

[Back]

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

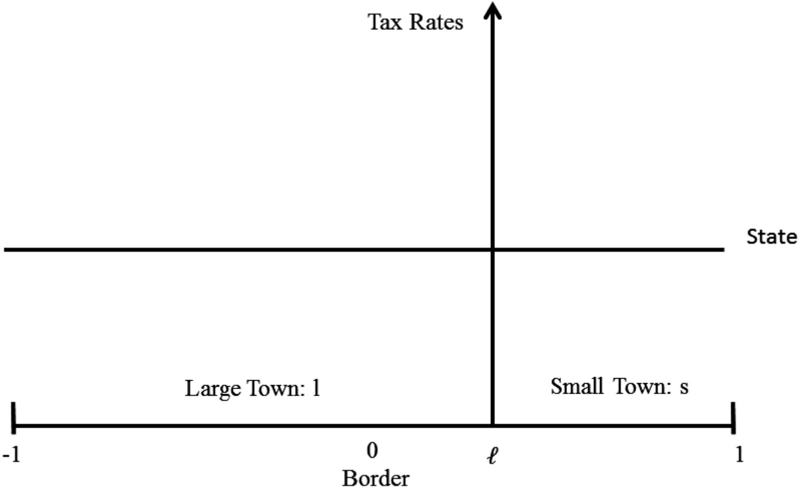
$$t_H = \frac{d}{2(1-\theta)} + \frac{t_L-b}{2},\ t_L = \frac{d}{2(1-\theta)} + \frac{t_H+b}{2}$$

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

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

The Role of Jurisdiction Size

[Back]



The Role of Jurisdiction Size

[Back]

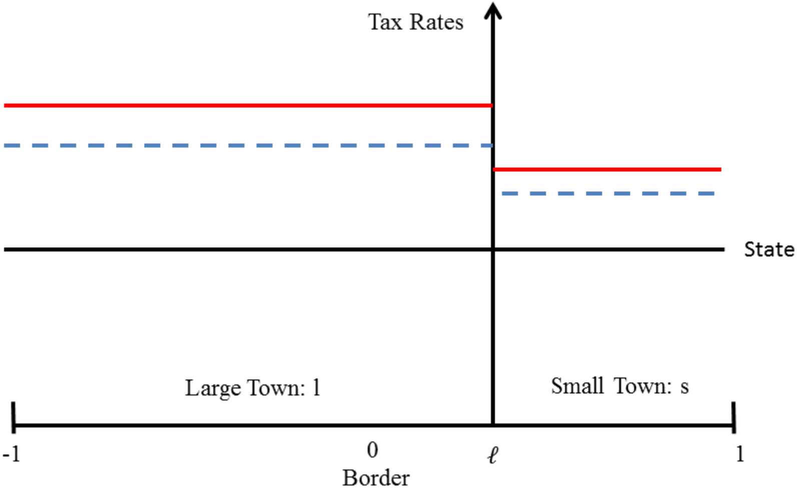
$$R_l = t_l(1+\ell+\frac{t_s-t_l}{d}) - \theta t_l^2 \text{ and } R_s = t_l(1-\ell-\frac{t_s-t_l}{d}) - \theta t_s^2$$

$$\text{Solution: } t_l^I - t_s^I = \frac{2\ell d}{3+2d\theta} \Rightarrow \frac{\partial t_l^I}{\partial\theta} < 0,\ \frac{\partial t_s^I}{\partial\theta} < 0$$
$$\text{and} \left|\frac{\partial t_l^I}{\partial\theta}\right| - \left|\frac{\partial t_s^I}{\partial\theta}\right| = \frac{4\ell d^2}{(3+d\theta)^2} > 0.$$

- Tax rates fall in the presence of the tax haven; moreso in big town.

The Role of Jurisdiction Size

[Back]



OLS vs. FRM

[Back]

	(1)	(2)	(3)
	OLS	Fractional	Tobit
Multiple	-.083*	-.075**	-.131*
Providers (I)	(.044)	(.038)	(.070)
N	14,459	14,459	14,459
Jurisdiction Size	Large	Large	Large
Controls	Y	Y	Y
State Fixed Effects	Y	Y	Y

Test of Internet Differences at Borders

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	(1)	(2)	(3)
	Polynomial Regression		Local Linear
Effect of Switching (Low to High)	-.038	.058	-.010
	(.039)	(.038)	(.030)
R^2	.357	.377	-
Border Fixed Effects	N	Y	N
State Fixed Effects	Y	N	N

Identification Using Within MSA Discontinuities

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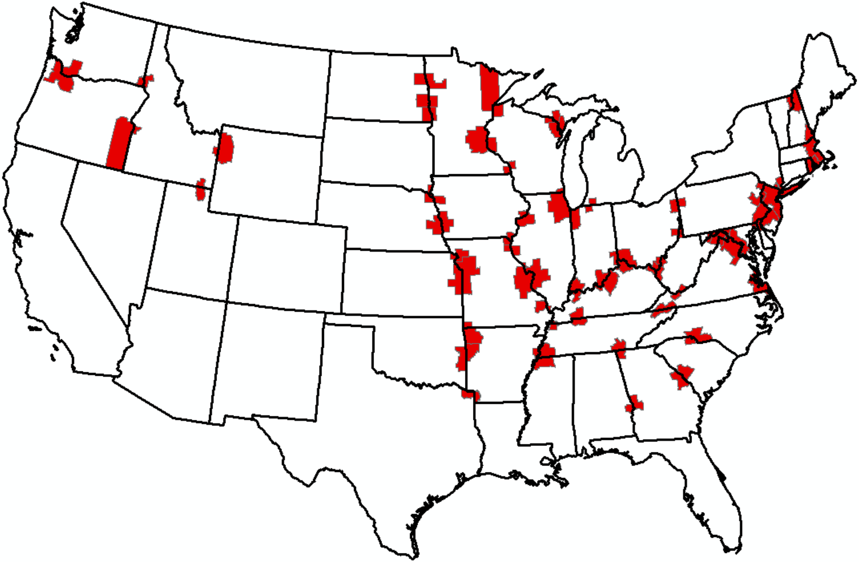

Identification Using Within MSA Discontinuities

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Marginal Effect	(1)	(2)
Low Tax Side of MSA	-.677*	-.610*
	(.349)	(.321)
High Tax Side of MSA	-.031	-.018
	(.171)	(.129)
N	1297	1313
Dependent Variable	Town	Town
Sample	Large Towns	Large Towns
High-Tax State	If state is higher than nearest neighbor	If state is highest in the MSA
Standard Errors	Cluster MSA	Cluster MSA

Measurement Error and Multiple Proxies

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- Using a proxy variable induces attenuation bias in the estimated coefficient.
- Furthermore, by using a single proxy variable – when I have multiple possible variables available – I am not using a great deal of information.
- Lubotsky and Wittenberg (2006) show how attenuation bias can be maximally reduced and develop a procedure that allows the researcher to use multiple proxies in the estimating equation.

Lubotsky and Wittenberg (2006)

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- Estimate

$$\tau = \tilde{\alpha} + \sum_{k=1}^{n} b_k p_k + \zeta + \sum_m X_m \tilde{\gamma}_m + \tilde{\varepsilon},$$

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

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

- Which is equivalent to using the index

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

Results

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	(1)	(2)
LW Low-Tax State	-.375***	-.134***
	(.089)	(.041)
Single Proxy Comp	-.204**	-.011
LW High-Tax State	-.081*	-.046**
	(.049)	(.021)
Single Proxy Comp	-.006	.004
N	4707	5085
R^2	.703	.600
Dependent Variable	Town	Town
Sample	Large	Small

Lightning and IT

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- Andersen, Bentzen, Dalgaard and Selaya (2012, *ReStat*) show that the flash density of lightning strikes is a powerful predictor of IT growth over the 2000s and can be used as an instrument in an economic growth context.
  - Intuition: lightning strikes cause power outages, which raise the cost of investing in Internet technologies, which reduces usage
- Lightning is not likely to be correlated with tax rates.
  - Lightning may be correlated with weather related amenities; if these amenities are correlated with sales tax rates, then the instrument will not work.
  - To reduce this possibility, I include Census Region dummies.

Specifics on the Instrument

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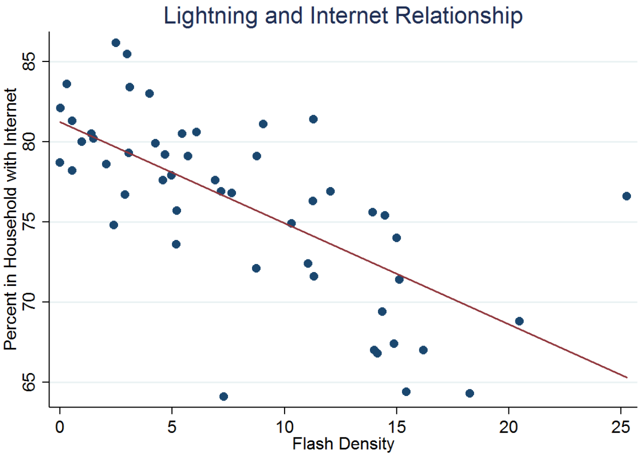
- At the state level, I calculate the flash density of lightning.



Results

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	(0)	(1)	(2)
First Stage: F Stat	OLS	11.747	11.747
Second Stage Marginal Effect	-.108 (.088)	-.344** (.175)	-.191*** (.070)
Tax Rate	State + Local	State + Local	Local
Controls	Y	Y	Y
Region Dummies	Y	Y	Y

Introducing Tax-Free e-Commerce

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- Goal: see how tax rates change if the Internet facilitates tax evasion
- The tax revenue lost is given by the function $f(t_i, \theta, t_i + T_i)$ where $f(0, \theta, T_i) = 0$.
- Denote $\theta \in [0,1]$ as a parameter that captures the fraction of consumers with access to the Internet.
- To obtain a closed form solution, assume the tax base declines linearly in the combined tax rate.

Exploiting Tax Changes

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	(1)	(2)	(3)	(4)
	Baseline		Binary Choice Regression	
	Panel	Border Design	Increase	Decrease
Full Sample	-.192***	-	-.044	.054**
	(.071)		(.049)	(.025)
Low Tax State		-.437**		
$d \to 0$		(.189)		
High Tax State		-.059		
$d \to 0$		(.104)		
N	7201	4693	7201	7201
Dependent Variable	Town	Town	Town	Town
Sample	Large	Large	Large	Large