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A World Without Borders Revisited: The Impact of Online Sales Tax Collection on Shopping and Search

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I study the effect of closing the online sales tax loophole on online spending and search. Using online shopping data, sales taxes, and Amazon's staggered sales tax collection, I estimate that household price elasticity is -1.9, implying a 13% decline in Amazon's revenues upon sales tax collection. After Amazon collects sales taxes, households increase their spending on Amazon's taxed competitors, but not its untaxed competitors. I find no evidence that households change their browsing or shift their spending offline. Collecting sales taxes online will help governments recapture lost taxes and increase online competition, but will not shift customers back offline.

JEL: D12, H31, H71, L81, M38

Keywords: sales tax, online shopping, e-commerce, Amazon, retail

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Online shopping has grown dramatically since 2000, reaching 11.8% of total retail sales in Q1 of 2020 (U.S. Census Bureau, 2020). Reasons for this growth include lower costs (travel, time, etc.), higher convenience, and more variety (Thau, 2013; Arnott, 2016). Until 2018, purely online retailers did not have to collect sales tax on online purchases because of a loophole in sales tax laws. As a result, purely online retailers could offer consumers, on average, a 7% discount compared to brick-and-mortar retailers, a large, structural price advantage. This discount came strictly at the expense of state and local tax revenues, with losses ranging from $8 billion to $33 billion in 2018 (U.S. Supreme Court, 2018).

In this paper, I estimate consumers' price elasticity using price increases generated by sales taxes on online purchases. Due to pressure from state and local governments and aggressive fulfillment center expansion, online retailers (particularly Amazon) collect sales taxes in many states. Combining data on online shopping with local tax rates and Amazon's tax collection behavior across states over time, I estimate how consumers' online purchasing changes when sales taxes are collected online. Furthermore, I extend this analysis to include measures of online browsing as well as overall household spending (including offline expenditures) to estimate whether consumers' search behavior or their composition of online and offline spending changes in response to online sales tax collection.

I merge online shopping data with offline sales tax rates to estimate whether areas with higher tax rates respond more strongly to Amazon's sales tax collection. Previous research uses a variety of approaches to determine how sensitive consumers are to tax rates. Table 1 summarizes elasticity estimates from previous research. In the offline environment, research leverages cross-border variation in tax rates and estimates a wide range of elasticities from -30 to -0.2 (Asplund, Friberg, and Wilander, 2007; Agarwal, Marwell, and McGranahan, 2017; Davis, 2011; Agarwal et al., 2017; Mikesell, 1970). In the online environment, elasticity estimates range from -6 to 0, but early efforts often used data from before 2001, i.e., before the mass adoption of the internet and before groundbreaking innovations like rating

systems and free shipping were effectively implemented (Scanlan, 2007; Ballard and Lee, 2007; Alm and Melnik, 2005; Goolsbee, 2000). Recent work leverages detailed online shopping data, but often is limited to particular websites, product categories, or states (Einav et al., 2014; Anderson et al., 2010; Ellison and Ellison, 2009; Hu and Tang, 2014). My paper extends the work of Baugh, Ben-David, and Park (2018) and Houde, Newberry, and Seim (2017) by incorporating data on browsing and total household expenditures to present a fuller picture of how household shopping behavior changes in response to Amazon's sales tax collection.

Table 1—Estimated Elasticities

Elasticity Type	Paper	Estimate
Cross-border Price-Expenditure	Asplund et al. (2007) – Foreign price	0.2 to 0.5
	Asplund et al. (2007) – Domestic price	-0.2 to -1.3
	Agarwal et al. (2017)	-2 to -30
	Davis (2011)	-2.2 to -3.6
	Agarwal et al. (2017)	-2.3
	Mikesell (1970)	-6.3
Tax-Purchase	Scanlan (2007)	0.0
	Ballard and Lee (2007)	-0.2
	Alm and Melnik (2005)	-0.5
	Einav et al. (2014)	-1.8
	Goolsbee (2000)	-2.3
Tax-Quantity	Anderson et al. (2010)	-1.9 to -2.9
	Ellison & Ellison (2009)	-6
Tax-Expenditure	Baugh et al. (2018)	-1.2 to -1.4
	Houde et al. (2017)	-1.3
	Hu and Tang (2014)	-3.75 to -4.5

Note: Early research focused on how taxes influenced the binary decision of whether or not to make an online purchase. Subsequent research has looked at how sales taxes affect actual online expenditures or quantities purchased. In order to distinguish between these concepts, I use "tax-purchase elasticity" to refer to the effect on the purchase decision, while "tax-quantity elasticity" and "tax-expenditure elasticity" refer to the effect on online purchase quantities and expenditures, respectively.
Source: Sources are the papers cited above.

I use a differences-in-differences approach to estimate a household's price elasticity. The expansion of Amazon's warehouse network and the passage of state laws requiring online sales tax collection generate variation in Amazon's tax liability across states over time. As a result, I can examine how household behavior changes

after Amazon collects sales taxes. Furthermore, I leverage variation in tax rates between counties to better examine if a household's responsiveness depends on its local tax rate.

I find that consumers reduce their Amazon spending by about 1.9% for each percentage point of sales tax applied online. Given an average sales tax rate of 7%, this elasticity translates into a 13% decline in retail spending on Amazon. Consumers also increase their spending on Amazon's taxed competitors by 1% per percentage point of sales tax collected by Amazon. This is one of the first papers to explicitly incorporate how consumer search behavior changes in response to tax changes. Even though consumers do shift their spending from Amazon to its competitors, I find no evidence that consumers' browsing habits are significantly affected by Amazon's sales tax collection. This is also one of the first papers to examine whether households shift their spending offline in response to online sales tax collection. I find no evidence that consumers make such a shift.

These findings show that state-level tax policy achieves its goals of increasing tax revenues and improving competition, but not necessarily of supporting local brick-and-mortar retailers. First, since consumers only shift spending between taxed online retailers, states and localities recover tax revenues that had disappeared when consumers made online purchases. At the same time, these policies restore competition between online retailers by removing the structural price advantage online retailers could pass on to customers. Finally, I find no evidence that consumers shift any spending back offline so these policies are unlikely to provide a boost for local brick-and-mortar retailers.

This paper is organized as follows. Section I describes the data. Section II analyzes how online spending responds to Amazon sales tax collection. Section III examines whether online browsing activity is affected by Amazon sales tax collection. Section IV analyzes tax responsiveness across all consumer spending modes, and Section V concludes.

I. Data Description

In this section, I describe the data used for my analysis and give a brief overview of their respective features.[1] Comscore's Web Behavior database provides information on household online shopping and browsing behavior. Nielsen's Consumer Panel data provide information on household shopping and purchasing decisions. Finally, Tax Data Systems provide information on local sales tax rates.

A. Comscore Web Behavior Database

I primarily use the Comscore Web Behavior database, which contains the online browsing and transaction activity of households that opt-in to have their internet activity collected by Comscore. The browsing data record how many minutes were spent and how many pages were viewed on each website. The transaction data record the website, product name, product category, price, quantity, and basket total (including shipping and taxes) of the purchase. The Comscore data capture all online activity of a household and are not limited to particular goods or retailers, in contrast with previous research. I use this breadth of information to capture whether households substitute to other retailers and estimate how their aggregate online spending changes when sales taxes are collected online.

I restrict my sample to households that have complete demographic information and remove any purchases in categories in which Amazon is a not competitor (e.g., no plane tickets, dating services) and focus on products that cost between $1 and $500 (in nominal dollars).[2] These filters reduce the original sample of about 576,000 households to about 206,000 households and a total of about 2 million transactions.

Comscore households are relatively representative of the U.S. population. The

[1] Researcher's own analyses derived based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

[2] This restriction is primarily to screen out extreme prices that may be generated by the Comscore monitoring software. For example, a $20 item reduced to $15 may mistakenly be recorded as $2015 because of how the price information is captured.

average household size is 3, average age is 47, and average income is $59,000. About 64% of the households have a child, and 13% are Hispanic. Households face an average sales tax rate of 7%. Overall, panelists are similar to the general population, but are slightly larger and more likely to have kids. Households rotate through Comscore's panel with a median tenure of 12 months (the 25th percentile is 9 months and the 75th percentile is 12 months). See Appendix Table A2 for full summary statistics.

Across the 2 million transactions I analyze, the average real price of products (in December 2016 dollars) is $39; 28% of products are purchased on Amazon, 42% from the website of a brick-and-mortar store, and the remaining products are purchased from another online retailer. For browsing behavior, the average household spends about two-and-a-half hours per month on shopping websites. Browsing on Amazon's untaxed competitors accounts for about one-and-a-half hours, browsing on Amazon accounts for about 20 minutes, and the remaining 40 minutes is on Amazon's taxed competitors. There is a wide range of shopping behavior with many households spending no time on shopping websites in a given month and others spending up to five hours per day. See Appendix Tables A4 and A5 for shopping and browsing summary statistics.

B. Nielsen Consumer Panel Data

I use the Nielsen Consumer Panel data from 2004–2016. This is a panel of about 178,000 unique households. I observe about 40,000 households each year from 2004–2006 and about 60,000 households each year from 2007–2016. Households scan all items that they purchase and then input information about quantities, prices, date of purchase, and store. Nielsen retains about 80% of its panel from year to year with the mean and median tenure of a household being four and three years, respectively.

Nielsen computes projection weights to ensure its sample is nationally representative. Weights are calculated to match population moments based on household

size, income, age, race, ethnicity, education, occupation, and presence of children. All analyses use these projection weights unless otherwise stated. Full summary statistics are reported in Appendix Table A7.

Unlike the Comscore data, store identities are anonymized, but they are classified into broad categories such as "Grocery Stores," "Electronics Store," and "Online Shopping." This categorization is enough to conduct a similar analysis as I do with the Comscore data, with the caveat that the Nielsen data primarily focus on basic household goods, so items like electronics and apparel will not be captured. For retailers with both an online and offline presence, Nielsen classifies them separately. For example, if Firm X has both offline stores and a website, detergent purchased from a Company X store will be from a different "retailer" than detergent purchased from CompanyX.com. In the first case, the retailer would be classified as a "Discount Store," and in the second, the retailer is classified as "Online Shopping."

For my analysis, I exclude tobacco and alcohol products because state and federal laws regulate purchasing these products online. I also remove households with a student or military head of household as well as those with an annual income of less than $5,000. Only about 2% of households are excluded, and I use the remaining 154,000 households for my analysis. See Appendix A for further details of sample construction.

C. Additional Data Sources

I obtain state, county, and local sales tax rates from Tax Data Systems, now part of Thomson Reuters. These data contain monthly tax rates at the zip code level. I manually compile information on state law changes and agreements with Amazon under which states began collecting taxes for online transactions. This information was gathered from a wide range of local, state, and national news sources. Prior to 2018, most states did not require online retailers to collect sales taxes. They have only been able to collect sales taxes from Amazon because of separate agreements

or because Amazon opened warehouses in their state.[3] Before 2006, Amazon only collected sales taxes in Kansas, Kentucky, North Dakota, and Washington state. By the end of 2016, Amazon collected sales taxes in an additional 25 states: Alabama, Arizona, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Maryland, Massachusetts, Michigan, Minnesota, Nevada, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

Figure 1 shows the wide variation in sales tax rates across the United States in December 2016. About 80% of counties have combined state and local sales tax rates between 5.3% and 8.3%. However, sales tax rates range from 0% to over 10% in Louisiana.

II. Amazon Sales Tax Collection and Online Spending

When shopping online, households can purchase from Amazon or one of its competitors. Amazon has two types of competitors: taxed and untaxed. Amazon's taxed competitors consist of traditional brick-and-mortar retailers, like Walmart and Target, which collect sales tax since they have physical locations across the country. Amazon's untaxed competitors are other online retailers, like Overstock.com or Etsy.com, which do not have physical locations across the country (generally just a headquarters location).

When Amazon begins collecting sales tax in a state, consumers could respond in a variety of ways. First, they may not change their behavior and continue purchasing purchase on Amazon (and maybe not even notice the sales tax). Second, they could switch to one of Amazon's competitors. They could switch to an untaxed competitor if they value the tax savings or possibly a taxed competitor that offers

[3] *National Bellas Hess v. Illinois* (1967) and *Quill Corp. v. North Dakota* (1992) ruled that retailers did not have to collect sales taxes in states where they did not have a physical presence. The court held that tabulating tax liabilities for over 6,000 different tax jurisdictions would place an undue burden on many of these firms (Atkins, 2005). The Supreme Court overturned these cases in *South Dakota v. Wayfair Inc.* (2018). Before 2018, consumers were supposed to self-report any unpaid taxes to the tax authorities, but compliance and enforcement were low, so these transactions were effectively tax-free (Manzi, 2015).

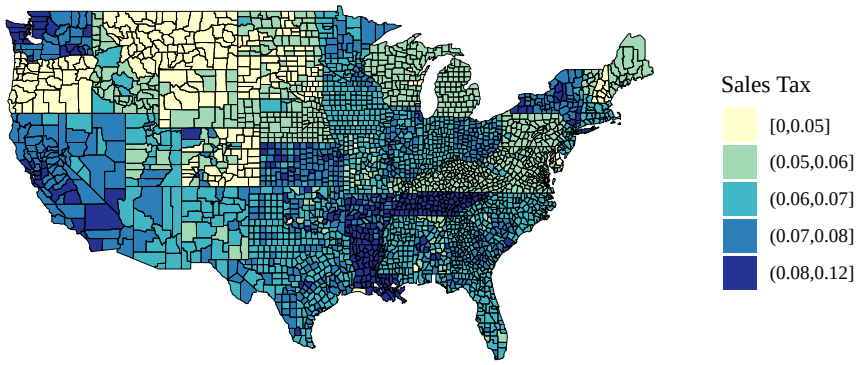

Figure 1. Sales Tax Rates by County (Dec 2016)

Note: Figure plots the spatial distribution of sales tax rates.
Source: Tax Data Systems

a better selection or lower tax-inclusive prices. I examine each of these in turn to see how spending on Amazon changes and how spending at Amazon's taxed and untaxed competitors changes after Amazon begins collecting sales taxes.

I use a differences-in-differences specification to identify the effect of Amazon's sales tax collection on a household's online spending:

$$Y_{ht} = \alpha + \beta AmazonCollect_{ht} * \tau_{ht} + \lambda_h + \lambda_t + \epsilon_{ht}, \tag{1}$$

where Y_{ht} measures real expenditures of household h in month t. $AmazonCollect_{ht}$ indicates whether Amazon collects sales tax (determined by month and state of residence of the household). τ_{ht} is the local sales tax rate.[4] Household and time

[4]The local tax rate could also be included separately, but given the household fixed effect, this would only be identified off of changes in local tax rates, which are relatively infrequent and when they do

fixed effects are captured by λ_h and λ_t. β is the coefficient of interest measuring how spending changes after Amazon begins collecting sales taxes relative to what would have been expected had they not started collecting sales taxes. All standard errors are clustered at the state level because once Amazon collects sales taxes, it collects them across the whole state.

The policy of whether or not Amazon collects sales tax in a particular state or county is plausibly exogenous to the household spending decision. Often, it is prompted by the opening of an Amazon warehouse in the state, but in a few cases, it is because of a change in state law. While there is a chance that these changes could be related to underlying economic fundamentals, Baugh, Ben-David, and Park (2018) show that sales tax collection by Amazon is not significantly related to state GDP growth, household income changes, or consumption declines. About 10% of households experience a change in Amazon's sales tax collection while they are in the sample.

Table 2 reports the estimation results. Columns (1) – (3) only include an indicator for whether or not Amazon collects sales tax, and then columns (4) – (6) allow for the response to vary with the sales tax rate. Column (1) demonstrates that Amazon spending decreases by an average of \$0.422 after Amazon collects sales taxes. Given that average monthly spending on Amazon is \$3.30 and the average sales tax rate is 6.8%, this equates to an elasticity of $\frac{-0.422/3.30}{0.068} = -1.88$. Columns (2) and (3) show that spending on Amazon's untaxed competitors does not significantly change while spending on its taxed competitors increases by \$0.549, implying a cross-elasticity of 1.14. Column (4) shows that the spending decreases on Amazon are stronger in areas with higher sales tax rates and the implied elasticity is a similar -1.87.[5] As before, there is no significant response on Amazon's untaxed competitors and a marginally significant increase on Amazon's taxed competitors. The spending increase on Amazon's taxed competitors implies an elasticity of 0.97. Overall, after Amazon collects sales taxes, households

happen, are small.

[5]See calculation as follows: 6.173 / 3.30 = -1.87.

reduce their Amazon spending and increase their spending on Amazon's taxed competitors.

Table 2—Online Spending Response to Amazon Sales Tax Collection

	Amazon	Untaxed Sites	Taxed Sites	Amazon	Untaxed Sites	Taxed Sites
	(1)	(2)	(3)	(4)	(5)	(6)
Collect	−0.422	−0.112	0.549			
	(0.183)	(0.150)	(0.249)			
Collect * Tax				−6.173	−2.043	6.811
				(2.715)	(2.165)	(3.545)
Household FE	Y	Y	Y	Y	Y	Y
Month-Year FE	Y	Y	Y	Y	Y	Y
Mean Spending	3.30	4.86	7.01	3.30	4.86	7.01
Mean Tax	0.068	0.068	0.068	0.068	0.068	0.068
Adjusted R^2	0.124	0.203	0.184	0.124	0.203	0.184
Observations			5,076,040			

Note: This table reports the estimation results of Equation 1, which regresses expenditures on an indicator for Amazon sales tax collection as well as household and month-year fixed effects. "Collect" is a dummy variable indicating whether Amazon collected sales tax in a particular household-month. "Tax" measures the local sales tax rate faced by a household in a particular month. All expenditures are real expenditures, deflated to December 2016 using the CPI. "Taxed Sites" refers to websites of retailers that have offline stores. "Untaxed Sites" are online-only retailers with no offline stores. Standard errors are clustered at the state level.
Source: Comscore (2006–2016)

My estimated elasticity of −1.88 is higher (in magnitude) than similar estimates from Baugh, Ben-David, and Park (2018) and Houde, Newberry, and Seim (2017). My estimate differs from Houde, Newberry, and Seim (2017) for two reasons. First, while I use the same underlying data, I extend my sample for another three years through 2016, which doubles the number of states in which Amazon begins collecting sales tax from 12 to 25. Second, their analysis aggregates the data to the county-year level, while I aggregate the data to the household-month level. I get nearly identical estimates if I aggregate to the county-year level and limit my sample to 2006–2013. My estimate also differs from Baugh, Ben-David, and Park (2018) likely because of differences in the underlying data. First, my analysis

spans 2006–2016 compared to 2011–2015, which adds an additional six states to my analysis.[6] Restricting my analysis to 2011–2015 generates a slightly smaller elasticity of -1.66, but this is still higher than the -1.2 to -1.4 estimated in Baugh, Ben-David, and Park (2018). The other possible contributor is the composition of our samples. The Comscore data captures all online activity on a household's computer, and panelists are recruited to provide a representative measure of US internet users' activity. On the other hand, the data used in Baugh, Ben-David, and Park (2018) are from an online account aggregator that likely targets younger, tech-savvy users interested in managing their finances effectively.[7] These users are probably more likely to shop online and may be less likely to switch from Amazon. This assertion is supported by comparing the average monthly spending on Amazon between the two samples. The average monthly Amazon spending of a Comscore user is only \$3.30, but this increases to \$12.20 when restricting to only households that have made purchases on Amazon. In comparison, the average household in Baugh, Ben-David, and Park (2018) spends \$39. Overall, my estimate is higher than previous estimates because I incorporate more recent data and (arguably) a more representative sample of online shoppers.

III. Amazon Sales Tax Collection and Online Browsing

The previous section shows that consumers are spending less on Amazon and more on Amazon's taxed competitors. Do these changes in spending translate into changes in search behavior? I estimate Equation 1 with Y being minutes spent on Amazon or one of its competitors' websites.

Table 3 shows the results of this estimation. Our previous results indicate that households reduce their spending on Amazon only after sales tax is collected online. Because of this, we might expect that this reduced shopping activity would

[6] Baugh, Ben-David, and Park (2018) also restrict their analysis to households that spend more than \$200 on Amazon in 2011, but their Appendix B shows that removing this filter does not impact their estimate.

[7] One of the most popular financial aggregators, Mint.com, is reported to have a primarily young, male demographic; 71% of users were male and 64% were under 30 years of age back in 2008 (Perez, 2008).

translate into reduced overall activity, measured in time spent on the website. Overall, I find no evidence that search on Amazon or its competitor websites is significantly affected by Amazon collecting sales tax. The lack of a significant browsing response may indicate that consumers are not changing their search behavior, but are simply switching their purchases away from Amazon since it no longer has a sales tax advantage.

Table 3—Online Browsing Response to Amazon Sales Tax Collection

	Minutes Browsed					
	Amazon	Untaxed Sites	Taxed Sites	Amazon	Untaxed Sites	Taxed Sites
	(1)	(2)	(3)	(4)	(5)	(6)
Collect	0.076	0.387	0.512			
	(0.435)	(0.977)	(0.640)			
Collect * Tax				0.369	6.317	7.160
				(5.695)	(12.840)	(9.243)
Household FE	Y	Y	Y	Y	Y	Y
Month-Year FE	Y	Y	Y	Y	Y	Y
Mean Browsing (Min)	11.71	66.66	27.98	11.71	66.66	27.98
Mean Tax	0.068	0.068	0.068	0.068	0.068	0.068
Adjusted R^2	0.463	0.410	0.386	0.463	0.410	0.386
Observations	5,076,040					

Note: This table reports the estimation results of Equation 1, which regresses expenditures on an indicator for Amazon sales tax collection as well as household and month-year fixed effects. "Collect" is a dummy variable indicating whether Amazon collected sales tax in a particular household-month. "Tax" measures the local sales tax rate faced by a household in a particular month. All browsing is in minutes. Standard errors are clustered at the state level.
Source: Comscore (2006–2016).

Households' relative unresponsiveness in search effort contrasts with the findings of Einav et al. (2014), which finds that when buyers realize sales taxes are added, they back out of the transaction. This could be due to differences in user search

between Amazon and eBay. On Amazon, the products are listed at a fixed price, while on eBay, a share of items is sold at auction. In 2010 (the data used in Einav et al. (2014)), 40% of eBay sales were from auctions (eBay.com, 2011). Given the risk of losing the auction, customers may be more likely to search on eBay relative

to Amazon, where there is no risk of losing the purchase. Even if there is an effect that I cannot detect, it is likely to be small changes in browsing time, which could be generated by the extra effort needed to complete the purchase (e.g., the time needed to enter in address and credit card information).

Overall, households reduce their pre-tax expenditures on Amazon and shift to Amazon's taxed competitors. In the next section, I examine whether households change their overall expenditures with a focus on whether their offline expenditures change in response to Amazon collecting sales tax.

IV. Total Consumer Expenditure Analysis

The Comscore data suggest that consumers reduce their Amazon expenditures when Amazon begins collecting sales tax, but they do not spend or browse significantly more on Amazon's online competitors. The Comscore analysis is limited to examining only online transactions and activity. Using Nielsen's Consumer Panel Data, this section examines how households' overall spending changes in response to Amazon's sales tax collection. Households scan all of the items that they purchase for at-home consumption and input information about their shopping trip, including whether the purchase was from an online or offline retailer.[8] Using these data, I can determine, for the common household items that are tracked, whether Amazon's sales tax collection changes overall household expenditures and whether households are shifting spending offline in response.

To identify changes in consumer expenditures, I estimate Equation 1 where Y is the expenditures in either the online-only (likely untaxed) channel or offline channel. Since Amazon is most competitive in delivering less perishable, non-food products, I also separately examine whether online or offline non-food spending is affected. About 45% of households experience a change in Amazon's sales tax collection during their tenure.

[8]Retailers are anonymized in Nielsen, so I cannot identify whether an online purchase is made at a taxed or untaxed website as I could in the Comscore data.

Table 4—Household Spending Response to Amazon Sales Tax Collection

	Real Spending				
	Total	Online	Offline	Online Non-Groc	Offline Non-Groc
	(1)	(2)	(3)	(4)	(5)
Collect	−0.682	0.036	−0.719	0.001	0.118
	(1.734)	(0.169)	(1.772)	(0.095)	(0.458)
Household FE	Y	Y	Y	Y	Y
Month-Year FE	Y	Y	Y	Y	Y
Mean Spending	316.39	4.7	311.69	2.93	94.74
Mean Tax	0.068	0.068	0.068	0.068	0.068
Adjusted R^2	0.531	0.331	0.532	0.226	0.399
Observations			7,792,355		

Note: This table reports the estimates from regressing monthly spending on an indicator for Amazon sales tax collection ("Collect") as well as household and month-year fixed effects and household demographics. Standard errors are clustered at the state level.
Source: Nielsen Consumer Panel Data (2006–2016).

Table 4 shows that a range of household spending groups are unaffected by Amazon's sales tax collection. Columns (1) – (3) show that there are no significant changes in total, online, or offline spending after Amazon begins collecting sales taxes. Even if there is an effect that I cannot detect, it is likely quite small. Part of this result is due to the fact that online shopping has low penetration into grocery and household non-durables (as indicated by monthly online spending averaging $4). Even when analyzing only non-food items, where online shopping is most likely, there is no significant effect and the range of possible changes is quite small.

Because online shopping for household non-durables is relatively infrequent, the numerous months with no online expenditures may be masking changes in online purchases when they are made. This finding is robust to limiting the sample to months when purchases are made (i.e., conditional on making a purchase). Overall, there is no evidence of households shifting their spending offline in response to Amazon's tax collection.

V. Future Research and Conclusion

Using data covering a broad range of online shopping activity, I find that consumers reduce their pre-tax spending on Amazon by about 1.9% for every percentage point of sales tax that Amazon collects. Furthermore, I find that households increase their spending on Amazon's taxed competitors by 1% for each percentage point of sales tax Amazon collects. Even though households change their spending, they do not significantly change their search behavior on Amazon or its competitors. Finally, I find no evidence that households shift any of their spending offline after Amazon collects sales tax.

In light of the recent Supreme Court case, *South Dakota v. Wayfair*, which increases state enforcement of sales tax collection online, state and local governments can expect a revenue boost because consumers are unlikely to shift their spending to untaxed channels. However, local policymakers and businesses will need to find other approaches if they want to encourage shoppers to move back offline. Online shopping is here to stay, and more empirical work will be necessary to understand how offline retailers can adapt to increased online shopping.

REFERENCES

Agarwal, Sumit, Nathan Marwell, and Leslie McGranahan. 2017. "Consumption responses to temporary tax incentives: Evidence from state sales tax holidays." *American Economic Journal: Economic Policy*, 9(4): 1–27.

Agarwal, Sumit, Souphala Chomsisengphet, Wenlan Qian, and Weibiao Xu. 2017. "Tax Differential and Cross-Border Shopping: Evidence from Singapore." *Georgetown McDonough School of Business Research Paper No. 3038550.*

Alm, James, and Mikhail I Melnik. 2005. "Sales taxes and the decision to purchase online." *Public Finance Review*, 33(2): 184–212.

Anderson, Eric T, Nathan M Fong, Duncan I Simester, and Catherine E Tucker. 2010. "How sales taxes affect customer and firm behavior: The role of search on the Internet." *Journal of Marketing Research*, 47(2): 229–239.

Arnott, Grant. 2016. "Why People Buy Online vs In Store – Not What You Think." *PowerRetail*. [Online; accessed 17-August-2020 through Internet Archive at `https://web.archive.org/web/20170825220915/https://www.powerretail.com.au/news/online-vs-store-research/`].

Asplund, Marcus, Richard Friberg, and Fredrik Wilander. 2007. "Demand and distance: evidence on cross-border shopping." *Journal of Public Economics*, 91(1-2): 141–157.

Atkins, Chris. 2005. "Important Tax Cases: *Quill Corp. V. North Dakota* and the Physical Presence Rule for Sales Tax Collection." Available at `https://taxfoundation.org/important-tax-cases-quill-corp-v-north-dakota-and-physical-presence-rule-sales-tax-collection`.

Ballard, Charles L, and Jaimin Lee. 2007. "Internet purchases, cross-border shopping, and sales taxes." *National Tax Journal*, 711–725.

Baugh, Brian, Itzhak Ben-David, and Hoonsuk Park. 2018. "Can Taxes Shape an Industry? Evidence from the Implementation of the Amazon Tax." *The Journal of Finance*, 73(4): 1819–1855.

Davis, Lucas W. 2011. "The effects of preferential VAT rates near international borders: evidence from Mexico." *National Tax Journal*, 64(1): 85.

eBay.com. 2011. "2010 Annual Report." Available at `https://d18rn0p25nwr6d.cloudfront.net/CIK-0001065088/f62994ae-7cd0-4396-a4b4-450b21fa8502.pdf`.

Einav, Liran, Dan Knoepfle, Jonathan Levin, and Neel Sundaresan. 2014. "Sales taxes and internet commerce." *American Economic Review*, 104(1): 1–26.

Ellison, Glenn, and Sara Fisher Ellison. 2009. "Tax sensitivity and home state preferences in internet purchasing." *American Economic Journal: Economic Policy*, 1(2): 53–71.

Goolsbee, Austan. 2000. "In a world without borders: The impact of taxes on Internet commerce." *Quarterly Journal of Economics*, 115(2): 561–576.

Houde, Jean-François, Peter Newberry, and Katja Seim. 2017. "Economies of Density in E-Commerce: A Study of Amazon's Fulfillment Center Network." National Bureau of Economic Research Working Paper 23361.

Hu, Yu Jeffrey, and Zhulei Tang. 2014. "The impact of sales tax on internet and catalog sales: Evidence from a natural experiment." *International Journal of Industrial Organization*, 32: 84–90.

Manzi, Nina. 2015. "Use Tax Collection on Income Tax Returns in Other States." Minnesota House of Representatives report. Available at `http://www.house.leg.state.mn.us/hrd/pubs/usetax.pdf`.

Mikesell, John L. 1970. "Central cities and sales tax rate differentials: The border city problem." *National Tax Journal*, 23(2): 206–213.

Perez, Sarah. 2008. "Who Really Uses Mint.com (And Other Banking 2.0) Services Anyway?"

Scanlan, Mark A. 2007. "Tax sensitivity in electronic commerce." *Fiscal Studies*, 28(4): 417–436.

Thau, Barbara. 2013. "New Study Reveals Why Consumers Really Shop Online (Surprise: It Isn't Low Prices)."

U.S. Census Bureau. 2020. "Quarterly Retail E-Commerce Sales."

U.S. Supreme Court. 2018. "South Dakota v. Wayfair Inc." *U.S.*, 585.

Data Appendix

A1. Comscore Web Behavior

This section provides more details about how I prepared the Comscore data for analysis. All Comscore data were obtained directly from Wharton Research Data Services (WRDS). I drop any households with incomplete demographic information. Additionally, I remove any households whose zip codes do not match with the Census Bureau's 2010 Zip-to-County Relationship file. Table A1 shows that 35% of households remain based on these filters. The low retention rate is primarily because a majority of Comscore households browse the internet and make no online purchases while they are in the sample. Table A2 reports the summary statistics for the Comscore panel.

Table A1—Comscore Sample

Step	HH
Starting HH:	586,420
Complete demographics:	585,867
Valid Zips:	576,457
Made Online Purchase:	206,435

Note: Table reports the number of households remaining in sample after each step of data cleaning.

For online transactions, I remove any transactions that are recorded for the same visit, same price, same time, and same product as a duplicate record. I also restrict my sample to products in categories that Amazon competes in, which excludes travel, dating, and financial products. Furthermore, I drop any transactions where the price is missing, less than $1 or greater than $500. Then, I remove any products that were sold by websites that do not feasibly compete with Amazon (e.g., daysinn.com or date.com).[9] Table A3 shows that most transactions are omitted because they are duplicates or in non-Amazon competitive categories.

[9]The full list of domains is available in the replication code.

Table A2—Comscore Panel Summary Statistics

Statistic	Mean	Median	St. Dev.	Min	Max	Census (2016)
Household Size	3.04	3	1.40	1	6	2.53
Age	46.65	47	12.59	19	65	51.9
Income	59.01	62.50	31.66	7.50	100.00	59.04
Child Present	0.64	1	0.48	0	1	0.42
Hispanic	0.13	0	0.34	0	1	0.13
Sales Tax	0.07	0.07	0.02	0.00	0.11	-
N (Household-Years)			261,416			

Note: Age and income are reported in bins, so the midpoint of each bin is used. "Child Present" indicates whether a child is present in the household. Census data come from "Historical Households Tables" and "Income and Poverty in the United States: 2016."

The remaining portion of transactions are removed because the household did not make any Amazon purchase while they were in the sample. Overall, 41% of all transactions are made in Amazon competitive categories. Tables A4 and A5 report the summary statistics for online purchases and browsing in the Comscore data, respectively.

Table A3—Comscore Transactions

Step	Transactions
Starting Transactions:	$4,934,867$
Unduplicated Transactions:	$3,956,424$
Amazon Categories:	$2,478,115$
Invalid Prices:	$2,269,680$
Invalid Domains:	$2,021,800$

Note: Table reports the number of transactions remaining in sample after each step of data cleaning.

A2. Nielsen Consumer Panel Data

This section provides more details about how I prepared the Nielsen Consumer Panel Data for analysis. I download the data directly from the University of Chicago Kilts Center for Marketing. I then remove any households with a military

Table A4—Comscore Transaction Summary Statistics

Statistic	Mean	Median	St. Dev.	Min	Max
Real Product Price	39.09	20.82	57.06	1.00	608.90
Sales Tax	0.07	0.07	0.02	0.00	0.11
Amazon Purchase	0.28	0	0.45	0	1
Offline Amazon Competitor	0.42	0	0.49	0	1
Online Amazon Competitor	0.30	0	0.46	0	1
N	2,001,485				

Note: Prices are deflated to December 2016 price levels using the CPI. "Sales Tax" indicates average local sales tax rate, not the average sales tax paid on online transactions.

Table A5—Comscore Browsing Summary Statistics (Minutes)

Statistic	Mean	Median	St. Dev.	Min	Max
Total	152.50	51.7	388.33	0	10,196
Amazon	18.52	0	83.19	0	8,864
Untaxed Competitor	93.46	16	346.00	0	10,176
Taxed Competitor	40.51	8	100.53	0	9,810
N (Household-Months)		2,559,012			

Note: Using 2006–2016 Comscore Web Behavior data, this table reports the distribution of monthly browsing durations, in minutes, on shopping websites.

or student head of household or those that are making less than $5,000 annually. Table A6 shows that only 2% of households are removed by these criteria. Table A7 reports the summary statistics for Nielsen households.

Table A6—Homescan Sample

Step	HH
Starting HH:	158,004
Exclude military and students:	155,256
Exclude Households under 5k:	154,352

Table A7—Nielsen Consumer Panel Summary Statistics

Variable	Mean	SD	25th Pc-tile	75th Pc-tile	Census (2016)
Household income ($000s)	56.53	31.41	27.5	85	59.04
Household size	2.55	1.45	1	3	2.53
Age	52.62	14.34	41.5	63	51.9
College Educated	0.38	0.48	0	1	0.37
Child present	0.33	0.47	0	1	0.42
Married	0.50	0.50	0	1	0.48
N (Household-Years)		637,493			
N (Households)		154,352			

Note: Data are weighted for national representativeness.

In the purchases data, I remove any alcohol and tobacco products as well as product categories that Nielsen has not consistently tracked over the full 2006–2016 period (i.e., "deferred modules"). I also exclude products that do not have Universal Product Codes (i.e., "magnet modules"). Finally, I remove any products with a recorded price of zero.

One final note for those familiar with Nielsen's data products. Theoretically, I could use the Scanner data to determine whether an "online" retailer and another retailer share the same parent company (for the set of retailers that Nielsen track in their data). Unfortunately, none of the "Online Shopping" retailer codes

are present in the Nielsen Scanner Data, so I cannot distinguish if the online retailer is the website of a traditional brick-and-mortar store (and thus taxed) or a stand-alone online store (and thus untaxed).