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

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For years, online retailers did not have to collect sales taxes at the time of sale. Over the past decade, states have passed laws to capture this lost revenue. 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 a household's tax 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 search behavior 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.

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I. Introduction

Online shopping has grown dramatically since 2000, reaching 11.3% of total retail sales in Q4 of 2019 (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. While consumers were supposed to self-report any unpaid sales taxes, compliance and enforcement were low (Manzi, 2015). 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 2018, the Supreme Court's *South Dakota v. Wayfair Inc.* decision upheld South Dakota's law compelling online retailers to collect sales taxes on all online purchases. As of October 2020, almost all states have "Marketplace Facilitator" laws requiring online retailers to collect sales taxes.

In this paper, I hypothesize that collecting sales tax on Amazon purchases will decrease Amazon's sales by removing its tax advantage. Furthermore, without this price advantage, consumers may search more widely and shift purchases to Amazon's competitors. Such a policy might increase offline purchasing since there is no longer a tax advantage online and offline purchases provide immediate utility. To test this hypothesis, I combine data on online shopping with local tax rates and changes in 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 consumer search 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 find evidence that Amazon spending declines after Amazon collects sales taxes, but I find no significant changes in consumer search or offline shopping.

I use a differences-in-differences approach to estimate a household's tax 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' search 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.

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).

The study closest to mine is Baugh, Ben-David and Park (2018) (BBDP). The authors document that consumers are sensitive to the introduction of sales taxes on Amazon and show that this sensitivity is higher for low-income households and for large purchases. Overall, they estimate an elasticity of -1.2 to -1.4.

My research extends BBDP along several dimensions. First, I use new data on search activity to provide direct evidence of the effects of sales taxes on consumer search. While BBDP provides some evidence that consumers respond more strongly to sales taxes when purchasing expensive items, I provide direct evidence that search activity is not significantly affected by sales taxes. Second, I examine substitution between Amazon and its taxed and untaxed online competitors. I then extend this analysis to incorporate purely offline spending. This approach is complementary to the findings of BBDP and substantially expands the scope of consumer response beyond only retailers that sell electronics. Finally, I use two very different datasets from BBDP, which validates their results. BBDP is based on an account aggregator which targets young and urban consumers while my analysis using Comscore data which are based on a more representative sample of households and capture all online activity of the household. My second dataset, from Nielsen, is even more representative and captures all household transactions, not just those made with credit or debit cards, so I can better track changes in offline spending.

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

II. 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 provides 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

[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.

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 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 C2 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 C4 and C5 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,

[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.

education, occupation, and presence of children. All analyses use these projection weights unless otherwise stated. Full summary statistics are reported in Appendix Table C7.

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 C 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][4] 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

[3]See Kacamak, Velayudhan and Wilking (2020) for a detailed discussion and analysis of Voluntary Collection Agreements where online retailers agreed to collect and remit sales taxes to the state.

[4]*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).

Virginia, and Wisconsin.[5]

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.

III. History of Online Sales Tax Collection

In the late 1990's and early 2000's, widespread internet adoption and the growth of online retailers enabled households to make tax-free purchases. Often, websites would advertise that customers would pay no sales tax on purchases, often without mentioning that customers were responsible for remitting the unpaid sales tax.[6] Unsurprisingly, since states did not enforce these self-reported tax provisions, compliance was low (Manzi, 2015).

However, in 2008, New York passed a law that forced online retailers to collect sales taxes for shipments to New York residents. This began a cascade of other "Amazon Laws," some of which forced online retailers to collect sales taxes by broadening the definition of "physical presence." Most states claimed that if a retailer had an "affiliate" (e.g., a blogger paid to refer readers to the online retailer) in the state, that established a physical presence. However, in response, most online retailers (notably Amazon and Overstock) shut down their affiliate programs. Shutting down affiliate programs ensured that an online retailer's "physical presence" was limited to the states where its headquarters and its warehouses were located.[7]

Since then, states became more aggressive and require online retailers to either notify customers of their tax liability or to collect and remit the sales taxes themselves. These requirements cleverly sidestep the rulings of the Supreme Court and Colorado's effort to do this was upheld in court (Lunder and Luckey, 2015). Since then, online retailers have less aggressively challenged similar laws. As of April 1, 2017, Amazon collects state sales taxes in all 45 states that have state sales taxes and the District of Columbia. However, Amazon may not necessarily collect local sales taxes and these arrangements can differ by state.

There have been two main initiatives to improve sales tax collection from online retailers. Congressional action has taken the form of the Marketplace Fairness Act of 2017 (its previous incarnations were the Marketplace Fairness Act of 2011, 2013, and 2015). It was introduced in the Senate on

[5] See Appendix for exact dates.

[6] See `https://web.archive.org/web/20180525192327/https://shop.ccs.com/` for an example.

[7] Furthermore, online retailers only needed to collect sales tax on items they directly sold or were stored in their warehouses on behalf of third parties (e.g., Fulfilled by Amazon program) (Faris, 2015). Third-party sellers on Amazon's Marketplace (who did not use Amazon's warehouses) did not have to collect sales taxes for out-of-state sales until late 2018–2020 after states passed "Marketplace Facilitator" laws (Craig, 2021; Dunn, 2020). Thanks to an anonymous referee for pointing out these nuances of tax law.

April 27, 2017, but died in committee. A more grassroots effort has been the Streamlined Sales Tax Project, started in 2000. This was created to help reduce the complexity in sales taxes that led to the *Bellas Hess v. Illinois* and *Quill Corp. v. North Dakota* decisions. By simplifying rules around sales tax, the hope is that complexity will no longer be a factor and there will be more fairness across the board (as well as higher revenues for states and localities). Currently, the project has 24 participating states that are working to create state-level administration of taxes, a uniform tax base, simplified tax rates, and uniform state sourcing rules. Most recently in 2018, *South Dakota v. Wayfair, Inc.* overturned the precedent of *Quill* and allowed states to collect sales taxes from online retailers even if the retailer does not have a physical presence in the state. Since the *South Dakota* decision, all 45 states with sales taxes have passed laws to collect sales tax from online retailers (Kacamak, Velayudhan and Wilking, 2020).

IV. Amazon Sales Tax Collection and Online Spending

This section first estimates how sensitive spending on Amazon is to sales tax collection. I find similar results as BBDP and this serves as an external validation of the Comscore data. I then extend my analysis to examine how spending at Amazon's competitors changes after Amazon collects sales taxes.

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 (stores trigger the "physical nexus" requirement for tax collection). 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 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 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.[8] $AmazonCollect_{ht}$ indicates whether Amazon collects sales tax (determined by month and state of residence of the household). τ_{ht} is the local sales tax rate.[9] Household and time 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.[10] 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.

For my differences-in-differences specification to be valid, the parallel trends assumption must hold. I estimate a modified version of Equation 1 to provide support for the parallel trends assumption.

$$Y_{ht} = \alpha + \sum_{n=-12}^{12} \beta_n AmazonCollect_{ht} * 1\{t = n\} + \lambda_h + \lambda_t + \epsilon_{ht}, \tag{2}$$

where I interact the collection term with an indicator for each of the 12 months before and after Amazon begins collecting sales tax ($n = -1$ is the reference group). Figure 2 plots the coefficient estimates for each type of spending (Amazon, Untaxed Sites, and Taxed Sites) and supports the parallel trends assumption because there are no significant differences prior to when Amazon starts collecting sales taxes. While the estimates are noisy when breaking out each month pre- and

[8] I use spending levels instead of log spending because there are many household-months with no online spending. In particular, there are households whose made no purchases on Amazon and/or other websites before Amazon's tax collection and make purchases after Amazon's tax collection. The log specification is not robust to these kinds of changes. To calculate a more robust elasticity, I use spending levels, which is the same strategy as BBDP. Houde, Newberry and Seim (2017) use a log specification, but aggregate spending to the county-year level, which guards against the issue.

[9] 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 happen, are small.

[10] Given that Amazon may open new warehouses based on demand forecasts, there is a risk of some endogeneity. Table B1 shows the results of including state-specific annual time trends and the results are virtually unchanged. Thanks to an anonymous referee for identifying this possibility.

post-collection, Amazon spending does not exhibit any trends before Amazon collects sales tax, but after Amazon collects sales tax, Amazon spending is persistently reduced for nine months after it collects sales taxes. On the other hand, spending on taxed sites increases about four months after Amazon collects sales taxes. Since the parallel trends assumption is supported, I estimate Equation 1.

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.[11] 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 reduce their Amazon spending and increase their spending on Amazon's taxed competitors. This suggests that a portion of Amazon's sales was attracted by the tax advantage.

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). Given that I use the same underlying data as Houde, Newberry and Seim (2017), I check if I can replicate their estimate. I get nearly identical estimates if I aggregate to the county-year level and limit my sample to 2006–2013. 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. The level of aggregation matters because using a log specification to estimate elasticities is more sensitive to the presence of zeros and these can bias the estimate towards zero. By aggregating to the county-year level, there are fewer county-years with zero spending, so Houde, Newberry and Seim (2017) avoid this issue. Since I am doing analysis at the household-month level, there are many months with zero spending. Therefore, I prefer to use a level specification that is less

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

sensitive to the presence of zeros and then approximate the elasticity from the coefficient estimates, which is the approach of Baugh, Ben-David and Park (2018). 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.[12] 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.[13] 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.

My estimate is also a conservative lower bound on a household's tax elasticity. First, the Comscore data do not distinguish between sales made on Amazon's main site and its Marketplace (where third-party sellers may not have to collect sales tax). BBDP show that Marketplace transactions also are reduced when sales taxes are collected on Amazon. Even without their evidence, having some portion of Amazon sales unaffected by the tax policy change would bias my estimate towards zero. Furthermore, some states exclude particular products from sales taxes (e.g., apparel in Minnesota). By a similar logic as above, having some products that are unaffected by the tax policy change would also bias my estimate towards zero. Using Nielsen data and adjusting for the tax-exempt status of various product categories, Kacamak, Velayudhan and Wilking (2020) finds that sales of tax-exempt items are unaffected by online sales tax collection.

V. 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

[12] 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.

[13] 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).

estimate Equation 1 with Y being minutes spent on Amazon or one of its competitors' websites.

I first test the parallel trends assumption. Figure 3 illustrates the event study estimation of Equation 1. As before, the estimates are quite noisy, but for Amazon and untaxed sites there is no significant evidence of pre-trends. However, for taxed sites, there is some evidence of a pre-trend, so it is important to examine how this may affect my estimates. Ultimately, the difference-in-difference estimator compares the differences before and after a policy is implemented. The negative pre-trend means that the browsing behavior is below what would be expected under parallel trends. This would exaggerate the effect of the policy and biasing it away from zero. Even with this bias, my estimates below are not statistically significant.

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 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.

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. Since I use time spent browsing to approximate search behavior, my measure may not be sensitive enough to pick up on the behavior identified in Einav et al. (2014). Finding the same item from an untaxed seller on eBay (or on Amazon) only requires a few more clicks and may not substantially increase the total time spent browsing. 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.

VI. 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. 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.

The Nielsen data are notably different from the Comscore data. First, since retailers are anonymized in Nielsen, I cannot identify whether an online purchase is made at a taxed or untaxed website as I could with Comscore. This will likely dampen any observable effect on online shopping because I cannot distinguish between the retailers affected by the policy and those not affected. However, any shifts in spending offline should be detectable since all offline retailers collect sales tax. Second, the products in Nielsen are a subset of those in Comscore. In particular, Nielsen-tracked goods are groceries and other consumer non-durables. Hence, categories like books, apparel, and electronics are not captured.

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.

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.

VII. 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.

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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.

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)

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).

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).

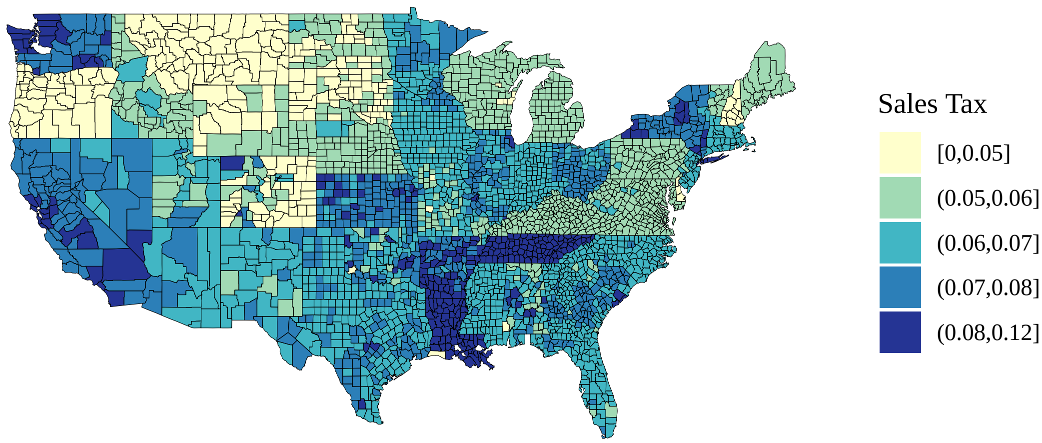

Figure 1. Sales Tax Rates by County (Dec 2016)

Note: Figure plots the spatial distribution of sales tax rates.

Source: Tax Data Systems

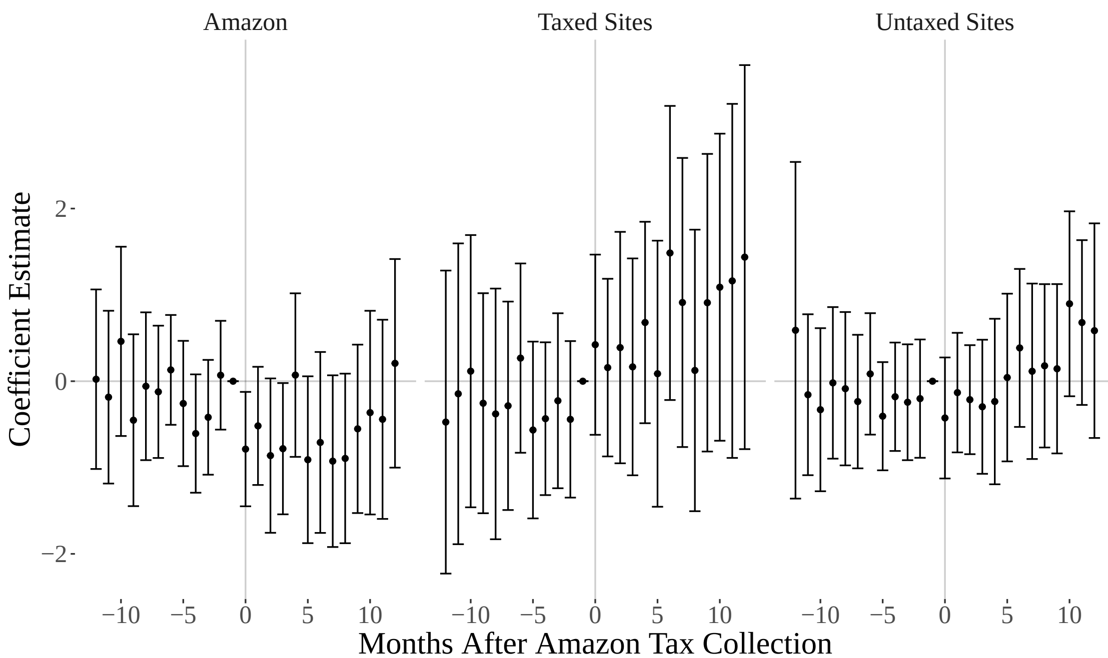

Figure 2. Event Study of Online Spending Pre- / Post-Amazon Tax Collection

Note: Figure plots the coefficient estimates of Equation 2 which regresses online spending on an indicator for Amazon tax collection interacted with the number of months pre- / post-collection and includes household and month-year fixed effects. 95% confidence intervals are also shown.
Source: Comscore

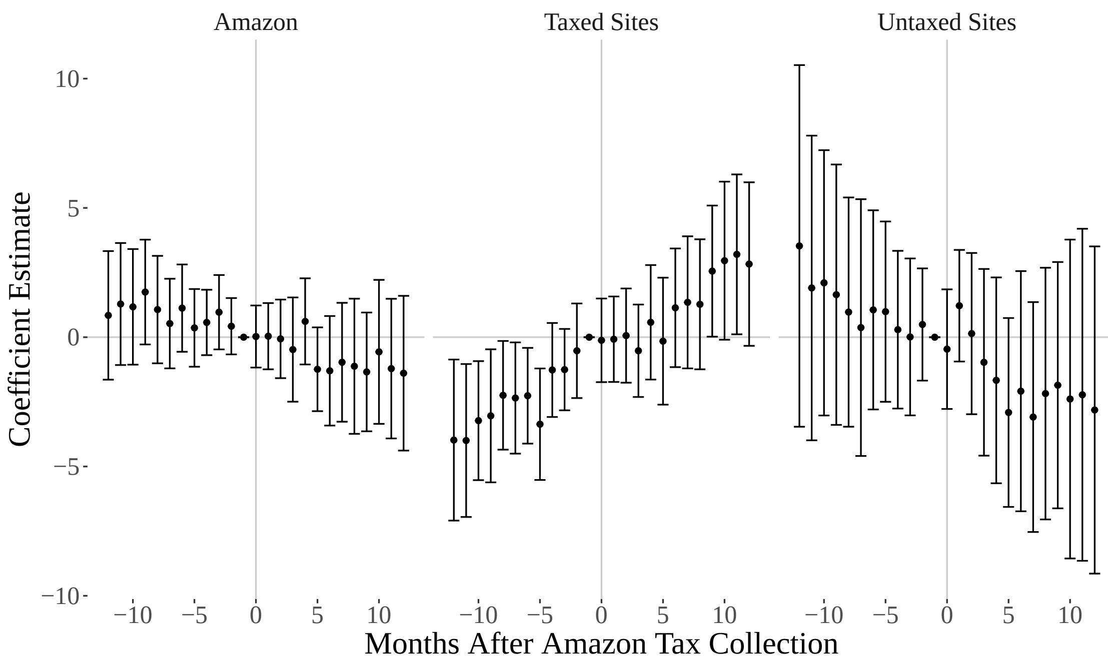

Figure 3. Event Study of Online Browsing Pre- / Post-Amazon Tax Collection

Note: Figure plots the coefficient estimates of Equation 2 which regresses online browsing on an indicator for Amazon tax collection interacted with the number of months pre- / post-collection and includes household and month-year fixed effects. 95% confidence intervals are also shown.
Source: Comscore

Tax Collection Timeline Appendix

This section shows the timeline for when Amazon began collecting sales taxes in various states.

Table A1—Timeline of Amazon Sales Tax Collections

Date	State
1995	Washington
2001	North Dakota
2004	Kansas
2005	Kentucky
06/01/2008	New York
07/01/2012	Texas
09/01/2012	Pennsylvania
09/15/2012	California
02/01/2013	Arizona
07/01/2013	New Jersey
09/01/2013	Georgia, Virginia
10/01/2013	West Virginia
11/01/2013	Connecticut, Massachusetts, Wisconsin
01/01/2014	Indiana, Nevada, Tennessee
02/01/2014	North Carolina
05/01/2014	Florida
10/01/2014	Maryland, Minnesota
02/01/2015	Illinois
06/01/2015	Ohio
10/01/2015	Michigan
01/01/2016	South Carolina
02/01/2016	Colorado
10/01/2016	DC
11/01/2016	Alabama
01/01/2017	Iowa, Louisiana, Nebraska, Utah
02/01/2017	Mississippi, Missouri, Rhode Island, South Dakota, Vermont
03/01/2017	Arkansas, Oklahoma, Wyoming
04/01/2017	New Mexico

Additional Tables

Table B1—Online Spending Response to Amazon Sales Tax Collection

	Amazon	Amazon	Untaxed Sites	Untaxed Sites	Taxed Sites	Taxed Sites
	(1)	(2)	(3)	(4)	(5)	(6)
amazon_collect	−0.422	−0.419	−0.112	−0.042	0.549	0.616
	(0.183)	(0.193)	(0.150)	(0.130)	(0.249)	(0.262)
Household FE	Y	Y	Y	Y	Y	Y
Month-Year FE	Y	Y	Y	Y	Y	Y
State Time Trend	N	Y	N	Y	N	Y
Observations	5,076,040	5,076,040	5,076,040	5,076,040	5,076,040	5,076,040
Adjusted R^2	0.124	0.124	0.203	0.203	0.184	0.184

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)

Data Appendix

C1. 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 C1 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 C2 reports the summary statistics for the Comscore panel.

Table C1—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.

Table C2—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."

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).[14] Table C3 shows that most transactions are omitted because they are duplicates or in non-Amazon competitive categories. 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 C4 and C5 report the summary statistics for online purchases and browsing in the Comscore data, respectively.

Table C3—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.

Table C4—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.

C2. 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 or student head of household or those that are making less than $5,000 annually. Table C6 shows that only 2% of households are removed by these criteria. Table C7 reports the summary statistics for Nielsen households.

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

Table C5—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.

Table C6—Homescan Sample

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

Table C7—Nielsen Consumer Panel Summary Statistics

Variable	Mean	SD	25th Pctile	75th Pctile	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).