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Smartphone Diffusion and Consumer Price Comparison Shopping Behavior: Implications for the Marketplace Fairness Act

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Abstract

Taxation of e-commerce sales is a contested issue with a potentially large impact on sales tax revenue collected by local and state governments. The stakes are high: the e-commerce share of total retail sales revenues has increased by about 16% each year since 2004, compared to 2.3% for total non-e-commerce sales revenues. Over this period, consumers not only enjoyed falling cellphone prices but also improved technology (smartphones) that allowed them to comparison shop almost instantaneously across state and national borders. We examine the impact of Nexus and effective online sales taxes on smartphone-assisted online purchases. We estimate that smartphone consumers are 6% more likely to comparison shop and 74% less likely to purchase from an online retailer if they live in a state with a Nexus sales tax. The implied tax elasticity of online purchases (6.8) is significantly higher than comparable recent estimates. These results suggest that local and state government forecasts of online sales tax revenue under the Marketplace Fairness Act legislation may be lower than previous estimates.

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1. Introduction

Electronic commerce (henceforth e-commerce) has grown steadily since dial-up internet access became more readily available in the mid-nineties (U.S. Census Bureau 2009). Total revenue from e-commerce at the retail level grew from $4.57 billion in 1999 to $59.55 billion in 2012 (4th quarter). As a percent of total sales revenue, e-commerce increased from 5.8% to 6.4% from 1999 through 2012 (2nd quarter). Although e-commerce's share of total retail sales revenue is still in the single digits, its growth has averaged 16.1% every quarter over the last decade compared to 2.5% for total retail revenues (excluding e-commerce) (U.S. Department of Commerce, U.S. Census Bureau).

As budgetary pressure persisted from the Great Recession, state governments attempted to capture a portion of the exploding e-commerce sales revenues from online purchases (Klein 2013). One such attempt is the Marketplace Fairness Act (MFA) of April 2013 currently under consideration in Congress. Under the MFA 2013, retailers with a remote presence (a *Nexus*) and a total of $1 million or more in total sales revenue (including business affiliates') are required to remit state sales taxes at the time of purchase.[1]

The MFA 2013 bill represents federal legislation that codifies the Streamline Sales and Use Tax Agreement. This agreement is the result of the Streamlined Sales Tax Governing Board which was formed in 2000 after the U.S. Supreme Court decisions in *Bellas Hess v. Illinois and Quill Corp. v. North Dakota.* The Board led the effort to simplify the collection and administration of sales and use taxes. This effort involved 44 states, the District of Colombia, local governments, and the business community under the sponsorship of the National Governor's Association and the National Conference of State Legislatures (see Herian 2012). Currently, legislatures from 24 states support the proposed MFA legislation. Among them, we identified 23 states with legislation requiring out-of-state retailers to remit sales taxes on online purchases even if the online retailer has no physical presence (but with a *Nexus*) in such state (Streamlined Sales Tax Governing Board, Inc. 2015) [2]. In states with *Use Tax* rules, however, households must still pay their state sales taxes on purchases made from online retailers without a Nexus in their state of residence. But, these taxes remain largely uncollected (NPR 2013).[3]

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[1] Our data identifies 23 states with Nexus-click legislation (Nexus Taxes) as of January 2013, excluding states with Use Taxes.

[2] The Senate MFA 2013 Bill seeks the authorization for Congress to require the collection of use and sales taxes: "Each Member State under the Streamlined Sales and Use Tax Agreement is authorized to require all sellers not qualifying for a small seller exception to collect and remit sales and use taxes with respect to remote sales sourced to that Member State pursuant to the provisions of the Streamlined Sales and Use Tax Agreement." MAT11760 (Section 3, subsection a).

[3] Avoidance of sales tax payments by consumers has a long history before the internet era. Consumers have engaged in cross-border shopping trips when faced with higher sales tax rates in their locality. Mail and telephone ordering capabilities have also contributed to lower sales tax collections (Fox *et al*. 2002).

Since the 2013 MFA, few iterations of the Act have been introduced to Congress. Most recently, the MFA of 2015 (Senate 698) was introduced to the U.S. Senate in March of 2015.[4] In 2014, the Senate passed the MFA of 2014. However, it languished in the House. In March of 2015, the U.S. Supreme Court remanded a challenge to the Colorado online sales tax legislation back to the 10th Circuit of Appeals.[5] In this case, the state of Colorado requires online retailers to inform buyers and the Colorado Revenues Office of any sales taxes due. Despite the inaction in Congress, some states (Louisiana and Oklahoma) are following the Colorado approach with varying degrees of success.[6]

While consumer purchasing behavior is well understood, the impact of real-time comparison shopping (smart-shopping) using smartphones has not been explored in the context of enacting the proposed Marketplace Fairness Act. This paper seeks to contribute to the literature on taxation policy and technology adoption with an analysis of the latest Pew Research Center survey data on smartphone usage in shopping (January 2013, Mobile Shopping Omnibus)[7]. Previous research captured some of the shopping behaviors of cell phone users using data from 2007 (Goolsbee *et al*. 2010). This paper contributes to the e-commerce literature by examining smartphone usage regarding purchases from an online retailer. Given the tremendous growth in e-commerce (approximately doubling from $135 billion to $263 billion since 2007), it is imperative that we understand the impact of improved technology (smartphones) on state sales tax revenues collected from e-commerce. [8]

2. Review of Literature

While vast research literature exists regarding government taxation at the federal, state, and local or county levels, research on e-commerce taxation is relatively new. Prior to the ubiquitous use of cellphones and smartphones, researchers examined state and local sales tax data from e-commerce that did not originate from smartphones.

Empirical e-commerce research tends to focus on goods where micro and macro data are readily available. For example, Thursby and Thursby (2000) examined consumer purchasing decisions on cigarettes and state sales taxes. Using data from 1972 to 1990, the authors found that increases in sales taxes on cigarettes resulted in higher rates of smuggling from lower to higher tax states. Extending this research to e-commerce, Goolsbee *et al.* (2010) examined sales taxes and e-commerce for cigarettes. Using a large dataset (CPS data for 1989, 1993, 1997-2001, and 2003), Forrester Research (2002), and tobacco sales tax rates and revenues across localities and states, the authors found that internet access increased consumer sensitivity to tax increases on cigarettes. More recently, Goel and Nelson (2012) found further support for such findings and concluded that internet diffusion has led to an increase in price elasticity of demand for cigarettes.

[4] The House version (H.R. 2775) was introduced in June of 2015. See:
https://www.congress.gov/114/bills/s698/BILLS-114s698is.pdf and
https://www.congress.gov/114/bills/hr2775/BILLS-114hr2775ih.pdf
[5] The decision allows the challenge to proceed at federal courts. See:
http://www.supremecourt.gov/opinions/14pdf/13-1032_8759.pdf
[6] http://marketplacefairness.org/news/
[7] The Pew Research Center makes the data, survey questionnaire, and summary statistics available to the public. The Pew Research Center bears no responsibility for the findings based on the data.
[8] By our calculation using Census data, 2014 e-commerce's share of total retail sales revenue (compared to the same 1st quarter in 2013) outpaces retail sales excluding e-commerce by nearly six-fold (15.5% v 2.5%) .

Beyond the market for cigarettes, researchers have examined other household data and online purchases. Goolsbee (2000) examined purchasing behaviors of over 25,000 internet users. He found that a 1% increase in the effective online sales tax rate would lead to a decrease of approximately 24% in online purchases. Alm and Melnik (2005) examined publicly available survey data (CPS) and found that sales tax rates played a significant role in consumers' decisions to make online purchases as a means to avoid higher local sales taxes. They estimated that a 1% increase in the effective online sales tax rate led to a 6% decrease in online purchases.[9] Using eBay data, Einav *et al.* (2014) estimated that a 1% increase in effective state sales tax rates increased online purchases from out-of-state retailers by approximately 2%, and decreased online purchases from in-state retailers by approximately 3-4%.

Smartphones are unique in the e-commerce literature. This technology allows consumers to engage in real-time price comparisons between all retailers, regardless of geographical distances. As a result, smartphones used for shopping purposes are of interest to academics and policy makers. For example, as e-commerce expanded and online shopping data became available, sales tax sensitivity estimates have increased. Earlier studies, such as Scanlan (2007) and Ballard and Lee (2007) estimated a higher implied tax elasticity among consumers living in high sales tax rates counties, compared to consumers living in low sales tax rates counties, including bordering counties. Controlling for geographical distance, Ellison and Ellison (2009) examined data on sales of memory modules at the state level. They found substantial online-offline substitution effects, strong tax-avoidance motives, and significant geographical purchase preferences. Similarly, Hortacsu *et al.* (2009) examined data from the online merchants Ebay and MercadoLibre. Their research points to location specific goods and geographical preferences as significant factors in consumer online purchases (home bias). Finally, two recent studies examined directly the impact of online (Nexus) sales taxes. Anderson *et al.* (2010) estimated that internet sales fell by 11.6% when consumers were required to pay sales taxes to online retailers. Baugh *et al*. (2014) estimated the elasticity of demand to be -1.3 using Amazon.com sales data.[10] Unfortunately, the transactional data from the five states used in this study do not differentiate between smartphone versus desktop and other media.

Related research examines the effects of e-commerce on firms' pricing decisions. Goel & Hsieh (2002) found that e-commerce increased contestability of markets. Previously, Brynjolfsson and Smith (2000) found evidence that internet retailers consistently charged lower prices than bricks-and-mortar retailers. Recently, Hoopes *et al*. (2014) examined the stock market returns of publicly traded online firms whose sales revenues would be directly affected by the Marketplace Fairness Act. The authors estimated that as the passage likelihood of the MFA legislation increased, analysts revised down their forecasts of the sales growth of these companies.

The primary concern in the literature on e-commerce is the implication for public policy and optimal taxation (Bruce *et al*. 2003). Agrawal (2015) examined the effect of the internet on

[9] Goel *et al.* (2006) examined data from the OECD countries and analyzed the market for internet services. Among their results, the elasticity of demand for internet access among subscribers is fairly inelastic. However, this measure differs greatly for non-subscribers depending on the inclusion of access price and telephone charges in the price variable.

[10] For large purchases (amounts greater than $300), the authors estimated the elasticity to be more than twice as large (-3.2).

tax competition between municipalities. He found evidence to support the claim that internet (broadband) penetration led to lower local tax rates in large municipalities.[11]

This paper makes two primary contributions to the literature. Until recently, data on consumer purchasing behaviors using smartphones were not publicly available for research. We examine data on smartphone comparison-shopping activities from the Pew Research Center (January 2013, Mobile Shopping Omnibus Survey). This allows us to determine purchasing decisions made as a result of price comparisons alone. It also allows us to exploit state sales tax rate differentials due to Nexus-click tax legislation. Second, this paper is the first to provide a measure of the probability of online purchases based on price comparisons using smartphones. We propose potential implications for state (and, possibly local) sales tax revenues based upon these findings.

3. Data and Measurement

The main source of data is the Pew Research Center 2013 Mobile Shopping Omnibus Survey from the Internet and American Life Project. The Pew Research Center is a nonprofit and nonpartisan organization that reports on facts and trends shaping the United States and the world, and funded by The Pew Charitable Trusts. Survey data produced by the Pew Research Center is widely used in academic research.[12] The Pew's Internet and American Life Project comprises surveys of internet access and usage, which was expanded to include mobile smartphones in 2013.[13]

The 2013 Mobile Shopping Omnibus Survey period was January 3-6 of 2013. Responses to the survey questionnaire were collected from a nationally representative sample of 1003 adults (18 years and older) living in the continental United States. Among the respondents, 502 responded to the survey on their cell phones and 501 responded on landline phones. In the dataset, there are 25 variables including a demographic weight variable. The dataset used in this paper is the public access version, which excludes zip codes, county, and phone numbers of the respondents. In this survey, respondents were instructed (variable *pial4*): *Thinking of the most recent time you used your cell phone to look up prices on a product while you were in a store, did you end up purchasing the product?* If the answer is "Yes", then ask *"Did you purchase the product in that store, another store, or did you purchase it online?"*[14] Among those who answered *Yes* or *No,* there were 190 observations. In addition, we merge this data with sales tax data (local and state) from the Tax Foundation.

[11] Best and Teske (2002) and Goldstein (2013) have documented interest group dynamics on tax legislations.

[12] Among the Economics and Finance journals that cited the Pew Research Center reports or used its datasets are Business Economics, Public Choice, the Journal of Economic Perspectives, and the American Economic Review, among others. A JsTOR database search (within Business, Economics, Finance, Technology, Statistics, and Public Policy topics) for "Pew Research Center" keywords produced over 252 articles that cited its reports or used its datasets.

[13] The addition of mobile internet access added one percent of new internet users to its 2007 Consumer Choice Survey dataset. Among the mobile smartphone users, Android based OS smartphones (25%) were roughly proportional to Apple's iOS (25%) iPhone (The 2013 Tracking Survey, Drew 2013).

[14] In our dataset, we omitted the observations from individuals who answered *Don't know* and *Refused.*

Table I: Data Summary statistics: the Pew Research Center 2013 Mobile Shopping Omnibus Survey[15]

Variable	Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
Age	976	50.6742	18.7742	18	92
Male	1003	0.4845	0.5000	0	1
Work Full Time	1000	0.4220	0.4941	0	1
Has Dependent Children at Home	1000	0.2790	0.4487	0	1
Hispanic	1003	0.0867	0.2816	0	1
White	1003	0.7737	0.4187	0	1
Black	1003	0.1216	0.3270	0	1
Asian	1003	0.0319	0.1758	0	1
Other Race	1007	0.0536	0.2254	0	1
Smartphone assisted comparison shopping: called family for advice, looked up review and price online	906	0.1126	0.3163	0	1
Smartphone price comparison- shopping: bought-from-bricks-and-mortar-store	190	0.5632	0.4973	0	1
Smartphone price comparison-shopping: bought-from-online-retailer	95	0.2421	0.4306	0	1
High School	995	0.2945	0.4560	0	1
Less than High School	995	0.0633	0.2437	0	1
Associate Degree	1003	0.0927	0.2902	0	1
College Degree	1003	0.1815	0.3856	0	1
Post Graduate or Professional Degree	1003	0.1396	0.3467	0	1
Local Sales Tax*	986	1.5001	1.4039	-0.03	4.87
State Sales Tax*	986	5.7155	1.4711	0	7.5
State with Nexus Sales Tax*	1007	0.6912	0.4622	0	1
Urban	1007	0.2969	0.4571	0	1
Rural	1007	0.2085	0.4065	0	1
Suburb	1007	0.4906	0.5002	0	1
Income	880	55,215.91	41,759.63	5,000	150,000

*Source: Tax Foundation, Marketplace Fairness Act, and Bloomberg BNA, 2014.

The average Pew Research Center 2013 Mobile Shopping Omnibus survey respondent is approximately 51 years old. Less than half of the respondents work full time, and about a third have dependent children at home. Approximately 30% of respondents are non-white (12.2%

[15] The Pew Research Center 2007 Consumer Choice Survey provides a similar set of variables with one exception: 46% of households in 2007 reported making an online purchase (any media), and 68.5% of households reported having internet access (any media).

Blacks, 8.7% Hispanics, 3.2% Asian, and 5.4% other race). 29.5% of of respondents are high school graduates, 18.2% have college degrees, and 14% have post-graduate or professional degrees. The data on income is bottom-coded ($5,000) and top-coded ($150,000) to nine categories. The average income is approximately $55,220. Most households are located in suburbs, and the mean local and state sales tax rates are 1.5% and 5.7%, respectively. Approximately 91% of respondents own a cell phone, and more than half (54%) own a smartphone. Among individuals who identified as engaging in smart-shopping (using a smartphone to consult friends and family on an item, checking prices against online retailers, and looking up product reviews online), approximately 24% purchased an item from an online retailer.[16]

Table II: Sales Tax Rates by Region

Region	**Nexus Sales Tax**	**Average Local Tax**	**Average State Tax**	**Average State and Local Tax**
Northeast	84%	1.46	5.35	6.81
Midwest	46%	1.08	5.85	6.93
South	78%	1.82	5.60	7.42
West	70%	1.53	6.02	7.56
Total	69%	1.50	5.73	7.23

Data sources: the Pew Research Center 2013 Mobile Shopping Omnibus Survey, and the Tax Foundation

[16] The Pew Research Center 2007 Consumer Choice Survey data covered individuals with similar socio-economic backgrounds. On e-commerce activities, it showed that 48% of individuals lived in surburbs, 46% lived in urban areas, and approximately 38% of rural residents purchased goods or services online. Across race, Asian/Pacific Islanders exhibited the highest e-commerce participation rate (68%), followed by whites (47%). The average sales tax rate across this sample is 5.34%. Nearly 70% of individuals surveyed had access to the internet, with 46% making an online purchase within the last year.

Table III: Sales Tax Rates by State[17]

State	Nexus Sales Tax (a)	Local Tax (b)	State Tax (b)	Sum of State and Local Taxes (b)
Alabama	0	4.45	4	8.45
Alaska	0	1.69	0	1.69
Arizona	1	2.56	6.6	9.16
Arkansas	0	2.61	6	8.61
California	1	0.88	7.5	8.38
Colorado	0	4.49	2.9	7.39
Connecticut	1	0	6.35	6.35
Delaware	0	0	0	0
Washington, DC	0	0	6	6
Florida	1	0.62	6	6.62
Georgia	1	2.99	4	6.99
Hawaii	0	0.35	4	4.35
Idaho	0	0.02	6	6.02
Illinois	1	1.88	6.25	8.13
Indiana	1	0	7	7
Iowa	0	0.82	6	6.82
Kansas	1	1.95	6.3	8.25
Kentucky	1	0	6	6
Louisiana	0	4.87	4	8.87
Maine	0	0	5	5
Maryland	1	0	6	6
Massachusetts	1	0	6.25	6.25
Michigan	0	0	6	6
Minnesota	0	0.29	6.88	7.16
Mississippi	0	0	7	7
Missouri	0	3.23	4.23	7.46
Montana	0	0	0	0
Nebraska	0	1.28	5.5	6.78
Nevada	1	1.08	6.85	7.93
New Hampshire	0	0	0	0
New Jersey (c)	1	0 (-0.03)	7	7 (6.97)
New Mexico	0	2.13	5.13	7.26
New York	1	4.48	4	8.48
North Carolina	1	2.12	4.75	6.87
North Dakota	1	1.52	5	6.52
Ohio	0	1.3	5.5	6.8
Oklahoma	0	4.17	4.5	8.67
Oregon	0	0	0	0
Pennsylvania	1	0.34	6	6.34
Rhode Island	0	0	7	7
South Carolina	0	1.08	6	7.08
South Dakota	0	1.82	4	5.82
Tennessee	1	2.44	7	9.44
Texas	1	1.89	6.25	8.14
Utah	0	0.72	5.95	6.67
Vermont	0	0.14	6	6.14
Virginia	1	.	.	.
Washington	1	2.36	6.5	8.86
West Virginia	1	0.04	6	6.04
Wisconsin	1	0.43	5	5.43
Wyoming	0	1.34	4	5.34
Total	**69%**	**1.50**	**5.72**	**7.22**

(a) Status as of December 2013. Source: Bloomberg BNA (2014).
(b) Reported tax rates effective as of January 2013. Source: Tax Foundation
(c) The state of New Jersey has a net local tax rate of -0.03. The value is recoded 0 for regression purposes.

[17] From January 2013 to August 2015, tax rates have remained fairly constant. Three states reported higher sales tax rates and an equal number reported lower sales tax rates. At the local level, however, sales tax rates were more fluid. About half of the states surveyed saw an increase in local taxes, with four states reporting slight decreases in average local sales tax rates. Overall, combined (state and local) tax rates have increased for 24 states, decreased for 9 states, and did not change for 16 states.

4. Methodology

We adopt a theory-guided approach to the empirical analysis of the data. The theory is the standard household consumption model expanded to include e-commerce purchasing behavior: in a simplified world with only three goods, two goods are sold by bricks and mortar stores (*X* and *Z*) and one that is sold online (*Y*). Good *Z* is considered to be unique to traditional or bricks and mortar stores, while goods *X* and *Y* are perfect substitutes. [18] Indirect utility functions (V_1 and V_2) in the following forms allows us to isolate the partial derivative of online purchases with respect to tax rate:

$$V1 = V(B, \pi X, \pi Z) \text{ when } X \text{ is } > 0 \text{ and } Y = 0 \quad (1)$$

$$V2 = V(B, \pi Y, \pi Z) \text{ when } X \text{ is } = 0 \text{ and } Y > 0 \quad (2)$$

Where total expenditures for *X, Z*, and *Y* are πX , πZ, and πY. For good *X,* sales tax rate *t* applies. Since the empirical interest resides on the impact of sales taxes on the probability of making an online or e-purchase of good *Y* (perfect substitute to *X*), the probability of making an online purchase is:

$$Pr(\text{e-purchase}) = Pr(V_2 - V_1 > 0) \quad (3)$$

The consumer makes an e-purchase if $V_2 > V_1$, therefore an increase in *t* increases the probability of e-purchase by increasing the relative cost of *X* to *Y* since $\frac{\partial \pi_Y}{\partial t} = \mathbf{0}\ \frac{\partial \pi_X}{\partial t} > \mathbf{0}$ in the partial derivative expression:

$$\frac{\partial Pr(\text{e-purchase})}{\partial t} = \frac{\partial V_2}{\partial \pi_Y} \cdot \frac{\partial \pi_Y}{\partial t} - \frac{\partial V_1}{\partial \pi_X} \cdot \frac{\partial \pi_X}{\partial t} > \mathbf{0} \quad (4)$$

To find the probability of making an e-purchase, we estimate a Probit model by the maximum likelihood method. In the standard Probit model, a dummy variable takes the following values[19]:

$$y = 1 \; if \; y*_i > 0$$

$$y = 0 \; otherwise$$

The likelihood function is:

$$L = \prod_{y_i=0} F(-\beta' x_i) \prod_{y_i=1} [1 - F(-\beta' x_i)] \quad (5)$$

Assuming $u_i \sim IN(0, \sigma^2)$, the functional form is:

$$F(-\beta' x_i) = \int_{-\infty}^{-\beta' x_i/\sigma} \frac{1}{(2\pi)^{1/2}} exp(-\frac{t^2}{2}) dt \quad (6)$$

[18] We use the same notations as Alm and Melnik (2005).
[19] See Maddala 1999.

The derivatives for the probabilities in this model are:

$$\frac{\partial}{\partial x_{ik}}\phi(x'_i\beta) = \emptyset(x'_i\beta)\beta_k \quad (7)$$

Where x_{ik} is the vector of explanatory variables and β_k the k^{th} elements in x_i and β_i. In the probit model the derivatives are non-constant. The marginal effects are then calculated for a given set of values of x_i or at the means.[20]

The estimated empirical models are: (1) a Probit model estimating the probability of engaging in smartphone comparison shopping behaviors (defined as using a smartphone to call family or friends to inquire about a good in question for price comparisons, and looking up online reviews for a good) while shopping in a bricks-and-mortar store;[21] and (2) a Probit model estimating the probability of making an *online purchase* as the result of comparison shopping on *price*:

$Smart\text{-}Shop_i = 1 \text{ if } Smart\text{-}Shop_i^* = Z_i\ \gamma + e_i > 0;\ = 0 \text{ otherwise;}$ (8)

$Buy\text{-}Online_i = 1 \text{ if } Buy\text{-}Online_i^* = x_i\ \beta + u_i > 0;\ = 0 \text{ otherwise;}$ (9)

The estimate from the second regression allows us to extract the impact of pricing alone on online purchases that are not confounded by the use of smartphones for other purposes. The regressions are estimated with robust standard errors and weighted.

To capture the potential effect of sales taxes from the Marketplace Fairness Act, we add an indicator variable, *Nexus Sales Tax,* that equals 1 if the surveyed household resides in one of the states with Nexus-click legislation (Anderson *et al.* 2010).[22] To control for the effect of geographical distance between counties with differing sales tax rates and tax evasion behaviors by consumers, we control for (average) state and local sales tax rates.

The first Probit model (Smart Shopping) estimates the probability of using smartphones to look up prices, find online reviews, or call up family and friends for advice. The second Probit model (Buy-Online) estimates the probability of making an online purchase as the result of comparison shopping on price using smartphones.

$$Smart\text{-}Shop_i \text{ or } Buy\text{-}Online_i = \gamma 0 + \gamma 1\ Age_i + \gamma 2\ Male_i + \gamma 3\ Full\ Time_i + \gamma 4\ Dependent\ Children_i + \gamma 5\ Associate_i + \gamma 6\ College_i + \gamma 7\ Post\text{-}Graduate_i + \gamma 8\ Hispanic_i + \gamma 9\ Black_i + \gamma 10\ Asian_i + \gamma 11\ Other\ Race_i + \gamma 12\ Local\ Tax_i + \gamma 13\ State\ Tax_i + \gamma 14\ Nexus\ Sales\ Tax_i\ dummy + \gamma 15\ Income\ (<\$10{,}000)i + \gamma 16\ Income\ (\$10{,}000 - \$19{,}999)_i + \gamma 17\ Income\ (\$20{,}000 - \$29{,}999)_i + \gamma 18\ Income\ (\$30{,}000 - \$39{,}999)i + \gamma 19\ Income\ (\$40{,}000 - \$49{,}999)_i + \gamma 20\ Income\ (\$50{,}000 - \$74{,}999)_i + \gamma 21\ Income\ (\$100{,}000 - \$149{,}999)_i + \gamma 22\ Income\ (>\$149{,}999)_i + \gamma 23\text{-}25\ Region_i\ dummies + \gamma 26\text{-}27 Residential\ Area_i\ dummies + e_i$$

[20] Marginal effects at the mean are calculated at mean value of continuous variables and setting the dummy variables to zero.

[21] Since our data is limited, we do not estimate (or incorporate this aspect into the theoretical model) the probability of smart-shopping made by other media (desktop, laptop, tablet, cell phones). The survey design neglects households which do not own smartphones. Only households which reported owning a smartphone are asked about their comparison shopping behaviors. This more simplistic model allows us to focus on the smart phone comparison shopping behavior itself.

[22] Only states that have Nexus Sales Tax legislation effective as of December 2012 were coded 1.

We conjecture that the Nexus sales tax coefficient from the Probit model for Smart-Shop is smaller compared to that for online purchases (Buy-Online). It is possible that this estimate might be confounded by omitted variables in the regression models[23]. We control for the omitted variables effect with variables that are highly correlated with preferences for online shopping and internet penetration at the state level: demographic (age, gender, education, and race), economic (income brackets, full time work status), and geographical (region and residential area) variables (Ellison and Ellison 2009).[24]

5. Results and Policy Implications

The regression results are presented in Table IV.

[23] Ellison and Ellison (2009) provided evidence that consumers have strong preferences for the geographical location of the e-tailers, separately from the shipping time. Even controlling for geographical variability, omitted variable effects can confound state fixed effects (such as investment in technology in determining access to the internet), see Goolsbee and Guryan (2006).

[24] The estimated model (Probit model) on the probability of making an e-Purchase does not include a price variable for smartphone handsets. This factor (price) affects a household's decision to *own* a smartphone. Yet, given the limitations of the data (Pew Research Center 2013 Mobile Shopping Omnibus Survey), we do not have information on the make and model of the smart phones used by the surveyed household to estimate the average retail price of the smart phone. It is possible that a subset of households who own smart phones of different makes (for instance Apple iOS iPhone) would behave differently compared to households who own Android smartphones (such as Pre-Paid Tracfone from Wal-Mart) (Smith 2013). Additionally, a regression model estimating the probability of e-Purchase with state dummies halved the number of useable observations (90 to 43). Similarly, this particular dataset does not sample the state of Wyoming.

Table IV: Probit Models

Models	**Dependent variable: Smart-Shopping (price comparison, product reviews, or advice)**			**Dependent variable: Buy-Online (price comparison)**		
Variables	**Probit coefficient (a)**	**Marginal effect: dy/dx**	**Mean**	**Probit coefficient (a)**	**Marginal Effect: dy/dx**	**Mean**
Age	-0.0344	-0.0062				
	***	***	45.03	0.0100	0.0014	35.15
Male^	-0.4046	-0.0732				
	***	***	0.49	-0.7301	-0.1109	0.53
Full time^				2.2365	0.3593	
	-0.0607	-0.0110	0.48	***	***	0.52
Dependent children	0.0926	0.0171	0.36	-0.2460	-0.0357	0.51
Education^						
Associate degree				-1.8318	-0.1258	
	0.3533	0.0760	0.09	***	*	0.16
College degree				-1.2612	-0.1064	
	-0.2464	-0.0400	0.15	*	*	0.17
Post graduate degree	0.2963	0.0615	0.13	-0.6229	-0.0662	0.15
Race^						
Hispanic	0.2128	0.0424	0.14	-0.6071	-0.0688	0.21
Black	0.3994	0.0867		1.4988		
	*	*	0.12	*	0.4036	0.12
Asian				1.8836	0.5602	
	0.3093	0.0665	0.04	**	**	0.09
Other race	-0.1201	-0.0204	0.08	-0.2152	-0.0271	0.07
Sales taxes						
Local tax	-0.0550	-0.0100	1.54	0.0869	0.0125	1.30
State tax				0.7022	0.1014	
	-0.0097	-0.0018	5.73	***	**	5.97
Nexus sales tax^	0.3450	0.0570		-2.5902	-0.7360	
	*	**	0.72	***	***	0.83
Income categories^						
Less than $10,000						
	-0.3845	-0.0569	0.09	-0.6750	-0.0652	0.09
$10,000 to under $20,000				-2.1642	-0.1066	
	-0.3154	-0.0487	0.10	*	*	0.08
$20,000 to under $30,000				-1.5284		
	-0.2058	-0.0338	0.12	*	-0.1070	0.13
$30,000 to under $40,000		-0.0626				
	-0.4222	**	0.13	-0.1402	-0.0188	0.12
$40,000 to under $50,000	0.1163	0.0224	0.08	-0.0318	-0.0045	0.09
$50,000 to under $75,000	0.0378	0.0070	0.16	0.2478	0.0397	0.20
$100,000 to under $150,000				-1.9634	-0.1018	
	-0.2899	-0.0450	0.08	**	*	0.08
$150,000 or higher	0.2910	0.0618	0.05	-0.2589	-0.0314	0.04
Geographical and residential areas^						
Northeast				2.3603	0.6892	
	-0.0238	-0.0043	0.18	**	***	0.14
South	-0.1415	-0.0250	0.36	0.9400	0.1691	0.34
West				2.0236	0.4749	
	-0.2625	-0.0436	0.24	***	***	0.30
Rural	-0.2474	-0.0402	0.15	-0.0679	-0.0094	0.08
Suburb				1.3312	0.2125	
	0.1638	0.0298	0.49	***	**	0.48
_cons				-5.4821		
	0.4823			***		
N=858				N=90		
Marginal effects after probit				Marginal effects after probit		
Pr(Smartphone: Shopping) (predict): Y= 0.1046				Pr(Smartphone: Buy-online) (predict): Y=0.0770		
Wald chi2(27)= 82.34				Wald chi2(27)=37.30		
Prob>chi2= 0.0000				Prob>chi2= 0.0895		
Log pseudolikelihood= -898.9453				Log pseudolikelihood= -112.7939		
Pseudo R2= 0.1850				Pseudo R2= 0.3895		

(^) dy/dx is for discrete change of dummy variable from 0 to 1
(a) Significance levels: ***=<1%, **=<5%, *=<10%
Reported coefficients are weighted regression results with robust standard errors.
Data source: Pew Research Center 2013 Mobile Shopping Omnibus Survey.

The probit results for "Smart-Shopping" *and* "Buy-Online" regressions estimate that a one percent increase in state sales tax rates (at the mean) would increase the likelihood to Buy-Online by approximately 10% as a result of price comparisons while shopping at a bricks-and-mortar store. Consumers in states with the Nexus Sales Tax are approximately 74% less likely to make an online purchase while price comparison shopping using a smartphone. The marginal effect of state tax rates on the likelihood of Buy-Online stays about the same for below average (5.7%) tax rates. But, the probability of online purchases decreases by approximately 12 percent for tax rates above 5.7%.

The socio-demographic set of control variables found results which indicate the need for further research: The regression results for *Smart-Shop* behavior found age (at the mean) and gender (male) to be negative predictors of the likelihood to shop using a smartphone (including using the smartphone to call a family member for advice, to engage in price comparisons, or to look up reviews online). The finding on gender revalidates the results of prior literature: males are approximately 7% less likely to smart-shop compared to women. Both age and gender are statistically significant (<1% level). Households in the income bracket of $30,000 to $40,000 were 7% less likely (<5% level) to engage in *Smart-Shopping* compared to those earning $75,000 to $100,000, while educational background (degrees completed) does not appear to affect the likelihood to engage in smartphone comparison shopping behaviors. Households in states with Nexus Sales Taxes are 74% less likely (<1% level) than households elsewhere to Buy-Online. The Nexus Sales Tax increases households' likelihood to engage in comparison shopping (Smart-Shopping) by 5.7% (significant at 10%). Since the model (probit) is non-linear, we also calculated the probability of engaging in smartphone-shopping behaviors at different ages. We find that as age increases, the probability of smartphone-shopping decreases at a decreasing rate. For example, a 20 year old individual would have a predicted probability of 36% of engaging in smart-shopping. The probability falls to 5% at age 60, and 1% at age 80 (An earlier study by Goolsbee (2000) found that younger internet users were less likely to consider tax rates in their decisions to make an online purchase, and singles engaged in e-commerce at a higher frequency.)

Other statistically significant variables correlated with smartphone price-comparison online shopping (*Buy-Online)* are: Full time households are 36% less likely to Buy-Online (significant <1%); Asians are 56% more likely to *Buy-Online* compared to whites; households in the income brackets between $10,000 - $20,000 and $100,000 - $150,000 are approximately 10% to 11% less likely to Buy-Online (compared to households in the $75,000 - $100,000 income bracket); households who have completed Associate and four year College degrees are approximately 11% - 13% less likely to buy online compared to households who have completed high school only (or less) (significant at 10% level); and among the broad geographical and residential control variables, the results suggested that households located in the Suburbs are 21% more likely to buy online compared to those located in Urban areas. Households in the West and the Northeast regions are 48% and 69% more likely to buy online compared to the Midwest, respectively. Unfortunately, due to the vagueness of the questionnaire wording in variable pial4 (comparison shopping on price alone) we are unable to account for retailer heterogeneity in our results.

Using this data and following Einav *et al*. (2014), we estimate the implied sales tax elasticity to be approximately 6.84: a 1% increase in the *effective online sales tax rate* would increase online purchases (as a result of price comparison using smartphones) by 6.84% (a substitute to bricks-and-mortar stores). The calculated tax elasticity for bricks-and-mortar store purchases was -1.2. Compared to values estimated by Einav *et al*. (2014), our estimated elasticity for online purchases is three times larger (more elastic) but lower than that estimated by Anderson *et al*. (2012). The tax elasticity for the bricks-and-mortar store is one-third as large (more inelastic).[25] These magnitudes are still within the range established in earlier literature.[26]

An examination of the shopping behaviors of all cell-phone users (not just smartphone owners) maybe a logical extension to this paper. The Mobile Shopping Omnibus Survey questionnaire does not survey the former regarding their Smart-Shopping experiences. It is possible that non smartphone subscribers may have a more elastic demand, similar to subscribers of internet services (Goel *et al*. 2006). This would cause our tax-sensitivity estimate to be lower. Another limitation of the dataset is the lack of information on the characteristics of the goods purchased. Identification of the particular goods and sources of price comparison search tools would be helpful in identifying the factors influencing demand elasticity. For example, Brynjolfsson *et al.* (2010) suggested a potential price differential impact of search technology improvement on high-SKU goods (RedLaser, an iOS mobile app, which allows consumers to price comparison shop by scanning bar codes of products). Similarly, future studies should address and control for mobile access penetration whenever consumer micro data can be matched to wireless accessibility at the county level (Agrawal 2015).

We caution readers about the limits of our findings. The Pew Research Center data (2013 Mobile Shopping, Omnibus) are cross-sectional household observations. In the regression model Buy-*Online* (as a result of price comparison) there are 90 observations.[27] We do not have enough observations within a state to control for state fixed effects. In addition, the observations on online purchases do not provide information on the item purchased, its price, or its quantity. Retailer characteristics are also not available in the dataset.[28] With respect to socio-demographic variables, we are also unable to control for population, the unemployment rate, or occupation.

In sum, this paper found evidence that consumers who reside in a state with a *Nexus Sales Tax* are 74% less likely to make an online purchase when price comparison-shopping using smartphones, and smartphone owners are about 6% more likely to comparison shop if they reside in a state with a *Nexus Sales Tax*. The predicted mean probability that a consumer would engage

[25] The elasticity is calculated by multiplying the coefficient for the log of 1 plus net overall sales tax rates (logit regression of the same specification) by 1 minus the predicted probability of engaging in the purchase behavior. The regression results of this model are available upon request. See Einav *et al.* 2014 for details.

[26] Given the small sample size of 90 (price comparison shopping that led to an online purchase), for robustness check we estimated a sample selection probit regression (*smart shop* with respect to *own cell phone*) and found coefficients with similar signs and magnitudes. Furthermore, the Wald test of independent equations could not reject the null at the 10% significance level.

[27] The number of observations in which households Smart-Shop is 190; of these, 90 households made an online purchase as a result of price comparisons.

[28] The wording of the questionnaire and answer options presented to the household in variable "pial4" (price comparison shopping) is not clear. It is not apparent what the surveyor expected the answer to mean by "Yes, purchased online." This could be interpreted to mean the consumer made an online purchase from an online retailer or the online presence of bricks-and-mortar stores with or without online presence (retailer heterogeneity).

in comparison-shopping is higher for lower sales tax rates (local and state levels). The predicted probability is highest for individuals younger than 45 years old. The results also indicated that males are less likely to comparison-shop (compared to females), while blacks are more likely to comparison-shop (compared to whites). However, Asians are most likely to *price* comparison-shop *and* purchase from an online store (compared to whites and all other races). In addition, the implied sales tax elasticity for bricks-and-mortar store purchases suggests that a 1% increase in effective online sales tax rates would lead to a 1.2% decrease in purchases in bricks-and-mortar stores. The substitution effect of online purchases is larger: a 1% increase in the effective online sales tax rate would lead to an increase of 6.84% in online purchases (online retailers are substitutes for bricks-and-mortar stores). Since e-commerce encompasses world-wide enterprises, consumers have options beyond shopping from online retailers located within the 50 states in the U.S. This larger than previously estimated impact on e-commerce revenue implies that local and state sales tax revenues captured by the MFA legislation may be lower than previous estimates.

As smartphones replace cell-phones as the standard medium of telecommunication among households, smartphone-assisted comparison shopping behaviors will become more prevalent. As actual online shopping data through smartphone, tablet, laptop, desktop, smart-watches, and mobile applications become available, researchers will be able to quantify further the impact of increased reliance on smartphone and related technology by consumers in their purchasing decisions.[29] More importantly, as smartphone mobile apps accelerate consumers' ability to comparison shop, the estimated tax elasticity might increase further for online purchases.[30]

[29] One such app is Shopular. Shopular is a couponing app that alerts the smartphone owner of deals (including personalized coupons) available for items while shopping in a bricks-and-mortar store (Shopular, the Mobile Industry's Hottest New Couponing and Shopping App, Tops 3 Million Users and Kicks its Brand Growth and Consumer Adoption into High Gear, 2014).Shopular, the mobile app, became available in the winter of 2012 and prior to the period surveyed in the Pew dataset used in this study.

[30] Brynjolfsson *et al.* (2010) provide an excellent overview of technology and non-technology drivers of product variety and concentration.

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