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ELECTRONIC PURCHASES, CROSS-BORDER
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ELECTRONIC PURCHASES, CROSS-BORDER SHOPPING, AND SALES TAXATION

By

Jaimin Lee

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ABSTRACT

ELECTRONIC PURCHASES, CROSS-BORDER SHOPPING, AND SALES TAXATION

By

Jaimin Lee

This dissertation reviews a variety of issues regarding online businesses, especially the relationship between sales taxes and Internet purchases. I investigate the relationship between them, and expand it to include cross-border shopping. I analyze the roles played by place of residence and the sales-tax rates in determining the decision of the consumer, using CPS (Current Population Survey) data for 1997 and 2001

I find that Internet shopping increases with the sales-tax rates. When a consumer lives in a jurisdiction with a high sales-tax rate, she/he would like to use Internet shopping. I also estimate the relationship between online purchases and the consumer's geographic characteristics. I expect that when she lives in a jurisdiction adjoining another jurisdiction with a lower sales-tax rate, a consumer would be more likely to travel across the border and purchase goods in a different jurisdiction, instead of making electronic purchases. According to my estimation, if the consumer lives in a jurisdiction adjoining a different jurisdiction with a lower sales-tax rate, an individual would be less likely to make Internet purchases.

I analyze the welfare effects of a revenue-neutral change in tax policies under which the sales and use tax is successfully collected from remote sales (online commerce and mail-order shopping). I compare the welfares of two cases: one is the case in which consumers can escape the sales and use tax by remote sales (the present real world), and

the other is that in which state and local governments can successfully collect the sales and use tax from remote sales (an alternative scenario). I use the excess burden to elucidate the economic inefficiency of the current sales tax system, which is characterized by tax evasion with mail-order shopping and e-commerce. A representative consumer can realize a welfare increase when state and local governments can successfully impose the sales and use tax on remote sales, and decrease sales-tax rates.

This dissertation is dedicated to my family

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Finally, I dedicate this dissertation to all of those whom I love and to all of those who have loved me.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 1: Online Business with Cross-Border Shopping

1.1. Introduction

1.1.1. Basic Idea

We expect that when a consumer lives in a jurisdiction with a high sales-tax rate, she/he would be more likely to make online purchases (Goolsbee, 2000). Consumers have an incentive to buy goods over the Internet, because they can evade sales and use taxes easily, since state and local governments do not have reliable methods to enforce their sales and use taxes. In spite of the fact that these purchases are officially subject to tax in 45 states, there is widespread tax evasion in online purchases.

Subnational governments in the US depend heavily on general sales taxes. The general sales taxes are roughly one-third of the total tax revenues for state governments, around 14 percent of local government tax revenues, and one-fourth of total state and local tax revenues (U.S. Census Bureau, 2001). However, the recent growth of electronic commerce generates various problems for state and local governments, such as use-tax evasion and erosion of the sales-tax base.

Currently, state and local governments cannot require online firms to collect sales or use taxes if they have no physical presence (nexus) in the originating jurisdiction.[1] For example, if Dell.com sells a computer to a resident of Texas, the state of Texas can require Dell to collect Texas sales taxes, because Dell is headquartered in Texas. However, when Dell.com in Texas sells a computer to a resident of Michigan, the state of

[1] Supreme Court rulings in 1967 and 1992 (Fox and Murray, 1997) held that states don't have the power to collect taxes on out-of-state mail-order companies that sell into their states (These rulings came in the cases of *National Bella Hess v. Department of Revenue of the State of Illinois* and *Quill Corp. v. North Dakota*).

Michigan cannot require Dell computer to collect Michigan sales taxes. When a Michigan resident buys a computer over the Internet, he is supposed to report that purchase to the tax authorities of the state of Michigan, and pay the use tax. In practice, however, this occurs rarely.[2]

The National Governors Association (NGA) has forecast that there may be more than $300 billion of electronic commerce by 2002. They estimate that states may lose up to $20 billion per year in tax revenues. Forrester Research Corporation (Williams *et al.*, 1999) forecasts $184 billion of electronic commerce in 2004. Bruce and Fox (2000) estimate that there will be $10.8 billion in sales tax revenue losses from e-commerce nationwide in 2003. So, the revenue loss is potentially a serious problem to the state and the local governments,[3] even though there is disagreement about the precise extent of the revenue loss.

Cross-border shopping is a form of tax avoidance, which consumers use for reducing their sales-tax burden. If a consumer buys goods in his own jurisdiction, it is generally difficult to evade the sales taxes. When he purchases a good in a neighboring state or county by crossing the border, it is also usually difficult to evade the sale taxes levied by neighboring jurisdictions. However, if the foreign local government has a lower sales-tax rate than his home jurisdiction, and if this tax differential dominates the traveling costs, the consumer may have an incentive to cross the border.[4]

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[2] However, in 2003, several large retailers announced that they would begin to collect state sales tax on their online sales. See Mike Wedeland (2003).

[3] Due in part to the erosion created by online purchases, the relative importance of the sales tax has decreased. From fiscal 1947 to fiscal 1997, general sales taxes produced more revenue than any other state tax (Mikesell, 2000). However, the general sales taxes were less than the individual income taxes from 1998 to 2001 in state government revenues, and the gap between them rose from $5 billion in 1998 to $28 billion in 2001.

[4] Ferris (2000) analyzes the reasons for the cross-border shopping of Canadian residents to U.S. markets, and suggests that the price differentials resulting from the tax differential between Canada and the U.S.

Residents of each state can purchase private goods in any of three ways. First, they can buy goods in their own jurisdiction, paying sales taxes if the jurisdiction levies a sales tax. Second, consumers can travel across a border and purchase products in different jurisdictions, paying the sales taxes of the bordering jurisdiction as well as the traveling costs associated with the border crossing. Finally, they might buy over the Internet after incurring shipping fees and information costs. As mentioned above, cross-border shopping is a sort of tax avoidance. On the other hand, Internet shopping is encouraged by the self-reporting feature of the use tax. This is a kind of tax evasion.

There are three information problems with online sales. First is the uncertainty about whether the credit card will be used improperly. Second is the fact that the consumer does not actually get to inspect the item at the moment of purchase. When it arrives, it may not be satisfactory, which would mean it would have to be returned, which is expensive. Third, there is the uncertainty about whether the item will be delivered in a timely manner. If the consumer perceives that the benefit of evading sales taxes is greater than the information costs, he would have an incentive to buy over the Internet. Although private goods may have the same qualities in the three markets, their effective consumer prices will be different, in general.

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play a major role in Canadian residents' crossing the border and purchasing liquor and tobacco in U.S. markets.

1.1.2. Literature Review

In spite of the increasing recognition of the importance of these issues, few articles analyze them economically. Fox and Murray (1997) conclude that electronic commerce should be taxed and that a destination-based tax system is appropriate for the sales-tax, even though a source-based tax system has clear compliance and administrative cost advantages over a destination-based tax system.[5] McLure (1997) proposes that all electronic sales should be taxed except for electronic sales to business. Weiner (1997) explains the possibility of taxing electronic commerce from the point of view of three features such as nexus, administration, and legislation. Hellerstein (1997) argues that a uniform taxation approach should be adopted, to cure many of the problems of taxing electronic commerce. However, their analyses are very normative and these papers are in the nature of surveys.

Goolsbee and Zittrain (1999) conclude that the potential revenue loss associated with electronic purchases is exaggerated by the press. They also examine the costs and benefits of enforcing taxes on online purchases. Goolsbee (2000) performs an empirical test of the relation between sales-tax rates and Internet purchases, using data for 1997 from Forrester Research (a market research company in Massachusetts),[6] and finds a positive relation between them. In other words, according to the results of Goolsbee, consumers who live in high sales-tax-rate locations are more likely to buy over the Internet, and Internet purchases are highly sensitive to local taxation.

[5] The destination-based system is to impose the tax at the site of consumption, and the comprehensive tax base is domestic consumption. The source-based system is to impose the tax where production takes place, and the comprehensive tax base is domestic consumption plus net exports. (Fox and Murray, 1997)
[6] This is a nationally representative survey of more than 110,000 U.S. households, and it includes various demographic characteristics and information on online purchases.

Goolsbee's paper is a pioneering work in the economic analysis of the electronic commerce, but there are some limitations. He has restrictive residence information about consumers. He only knows which metropolitan area a consumer lives in. He does not have information about the city or county which a consumer lives in. For example, he assumes that the sales-tax rate in the suburban area of Chicago is the same as that of Chicago's downtown. This might lead to measurement error for the tax rates in Goolsbee's regression analyses. I use a data set in which information on the county of residence is available. In order to avoid the measurement error problem, I define the sales-tax rate at the county level, and use the weighted average sales-tax rates of counties which consumers live in.

Goolsbee only considers the tax evasion aspect of Internet shopping, and he does not deal with cross-border shopping in the same framework. However, cross-border shopping is an important issue, because consumers make substantial use of cross-border shopping, to elude the sales-tax burden of their local jurisdictions. My studies include cross-border shopping as well as Internet shopping in the same framework.

Cross-border shopping has long been popular, and has been studied for a long time. Cross-border shopping occurs in the European countries because of the differences in their rates of value-added tax. Gordon and Nielsen (1997) estimate that 3.9 billion Danish Kroner of value added escaped taxation from Denmark in 1992 because of cross-border shopping.

In the survey of border crossing between the Republic of Ireland and the United Kingdom by Fitz Gerald (1989), residents living close to the border were most likely to buy goods in another country with a lower tax rate.

Lockwood (1993) compares the destination-based tax with the origin-based tax in small and large countries. He proves that only uniform taxation can guarantee the equivalence of destination and origin regimes. Ferris (2000) estimates the tax revenues forgone from the introduction of the Goods and Service Tax (GST) in Canada. He points out that the dramatic rise and fall of cross-border shopping in Canada between 1989 and 1994 was caused by the substitution of the GST for the Federal Manufacturer's sales tax.

I investigate whether online business can make a state or local government with a high sales-tax rate lose its tax base, and whether online business is very sensitive to sales-tax rates. I extend Goolsbee's model to consider a consumer's residence, and examine how the differences in the relative prices of online shopping and cross-border shopping affect a consumer's buying behavior. I set up a theoretical model, which assumes imperfect mobility on the part of the individual consumer, as well as use-tax evasion on Internet purchases. I test empirically the effect of local sales-tax rates and the consumer's geographic traits on the online business. I compare Internet purchases with the cross-border shopping effect.

1.2. Theoretical Background

In this model, I consider only the demand side; producers do not play an active role. The producer price of each good is fixed, and I use the small-country assumption. In other words, changes in sales-tax rates do not affect producer prices.

A resident can buy goods in local retail stores, or in the stores of another local jurisdiction with lower sales-tax rates,[7] or over the Internet. It is assumed that online stores do not collect the tax for the home jurisdiction. In this model, I assume that there is no risk of being caught engaging in use-tax evasion on Internet purchases. Instead, I will add costs of noncompliance (costs of tax evasion and tax avoidance) into the consumer prices when a resident buys goods either in other counties or over the Internet.

The producer prices are the same for a good regardless of where the good is purchased, but their consumer prices are different. I assume a representative consumer, so we do not need to discuss distributional issues. I assume that the sales-tax rate of the home county, t^h, may be greater than, equal to, or less than that of another county, t^f. In this model,[8] there is no lump-sum tax, and there are K kinds of goods, which can be taxed, in addition to labor, L, which is not taxed. The price of labor, w, is one, which means labor is the numeraire. The sales-tax rates in a jurisdiction are allowed to be different among goods.[9] The model can include the case of local jurisdictions that have a uniform rate, as well as the case of counties that have non-uniform rates. Important parameters are

x^h: vector of net purchases made in the home jurisdiction,

x^f: vector of net purchases made in the foreign jurisdiction,

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[7] I use the county as a measure of local jurisdiction in this model, because the data show which county and state a resident lives in. In some counties, the general sales-tax rates are different among cities. I use the population-weighted average sales-tax rates of each county, based on the sales-tax rates of the various cities.

[8] I will follow Lovely's model (1995), which analyzes cross-border shopping. However, she does not consider online businesses. I will add online purchases into the model, and change her model to compare Internet purchases with the cross-border effect.

[9] Some states have constant rates for a large number of goods, but other states have different sales-tax rates for different goods. Some states exempt food, but others do not.

x^i: vector of net purchases made on the Internet,

p_k: producer price of good k,

t^h: sales-tax rate in the home jurisdiction,

t^f: sales-tax rate in the foreign jurisdiction,

T: traveling costs to buy goods in the foreign jurisdiction,

I: information costs to search for goods over the Internet,

C: shipping fees to purchase goods over the Internet,

$q_k^h=p_k(1+t^h)$: consumer price of good k in the home jurisdiction,

$q_k^f(=p_k(1+t^f))+T$: consumer price of good k in the foreign jurisdiction,

$q_k^i(=p_k)+I+C$: consumer price of good k in online stores.

The important variables and parameters are the consumption vectors (x), producer prices (p), consumer prices (q), and noncompliance costs (T, C, and I).[10] The effective consumer price in the foreign jurisdiction, q_k^f, is composed of the producer price, p_k, and its sales-tax rate, t^f, and the consumer also has to spend traveling costs, T, to buy goods in the foreign jurisdiction; $q^f_k(=p^f_k(1+t^f))+T$. The consumer price for the Internet sales consists of the producer price, p_k, and information cost, I, and the economic agent should also pay the shipping fee, C, to purchase goods over the Internet; $q^i_k(=p_k)+I+C$.

In this model, it is assumed that consumer prices rise by exactly the amount of the sales taxes, and that sales taxes are fully shifted to consumers. However, it is arguable

[10] Economists often identify three kinds of social costs: efficiency, administrative, and compliance costs. I include another social cost, noncompliance costs. Compliance costs are the value of resources expended by taxpayers in meeting their tax obligations (Tran-Nam, *et al.*, 2000), and noncompliance costs are the value of resources spent by agents in escaping their tax obligations.

whether retail prices will rise by less than the full sales tax when residents of the jurisdiction can either migrate or cross borders to make purchases (Poterba, 1996). There is Internet shopping as well as cross-border shopping, which may induce less-than-full consumer price increases. However, in this section, my focus is not to estimate the degree of tax-shift. I assume here that the sales taxes are fully shifted to consumers, and that the consumer prices increase by the exact amount of the sales taxes.

Traveling costs (T) are one important part of the noncompliance costs. These traveling costs are a function of distance, *d*, and the vector of net purchases made in the foreign state, x_k^f. If a resident is going to cross the border and shop in a foreign state or county, he must pay traveling costs. *T* is an increasing function of distance, and non-decreasing in x^f_k. The relative size of cross-border shopping depends not only on tax differentials, but also on consumption technologies, which involve transaction and transportation costs.[11] Thus, I include traveling costs in my model, to consider the causes of cross-border shopping.

If a resident uses online businesses, he must pay a shipping fee, *C*, which is a function of the vector of net purchases made over the Internet, x_k^i. In this model, the shipping fee, *C*, includes not only explicit shipping fees, but also the costs associated with late delivery and uncertainty about delivery. We assume that *C* is a non-decreasing function with respect to x_k^i. Information costs, *I*, include the costs of computers and other instruments necessary to access the Internet, and the time to search for lower prices for goods. The consumer's problem is

[11] Scharf (1999) shows that the transaction and transportation costs are very important factors in cross-border shopping.

$$Max\, U(X) = U(x_1^h + x_1^f + x_1^i, \ldots, x_K^h + x_K^f + x_K^i)$$
$$x_k^j,\ j = h, f, and\ i:, k = 1,2,3, \ldots, K$$
$$s.t.\quad wL = \sum_{k=1}^{K} x_k^h (p_k + t_k^h) + \sum_{k=1}^{K} (x_k^f (p_k + t_k^f) + T(d, x_k^f)) + \sum_{k=1}^{K} (x_k^i (p_k + I) + C(x_k^i)) \tag{1.1}$$
$$x_k^h, x_k^f, \text{and } x_k^i \geq 0$$

where *U(.)* is a twice differentiable, strictly quasi-concave utility function, and L is labor supply. Let U_k^j be the first partial derivative of utility with respect to x_k^j.

The utility function is increasing with respect to the vector of net purchases made, and traveling costs are a quasi-convex function of the vector of net purchases made in the foreign state or county and the distance between the consumer's residence and the retail stores in the foreign jurisdictions. The shipping fee is increasing with respect to the quantity of Internet purchases. The Lagrange function for this problem is

$$L = U(X) + \lambda(W - \sum_{k=1}^{K}((x_k^h(p_k + t_k^h) + x_k^f(p_k + t_k^f) + T(d, x_k^f) + x_k^i(p_k + I) + C(x_k^i))) \tag{1.2}$$

I differentiate this function with respect to x_k^h, x_k^f, and x_k^i to maximize this function. I use Kuhn-Tucker conditions, because corner solutions can exist in this problem. In other words, consumers may choose to make zero purchases by one or more of the methods. The Kuhn-Tucker conditions for the consumer problem are

$$U_k^h - \lambda(p_k + t_k^h) \le 0, x_k^h \ge 0, (U_k^h - \lambda(p_k + t_k^h))x_k^h = 0$$

$$U_k^f - \lambda(p_k + t_k^f + T_2) \le 0, x_k^f \ge 0, (U_k^f - \lambda(p_k + t_k^f + T_2))x_k^f = 0 \quad (1.3)$$

$$U_k^i - \lambda(p_k + I + C') \le 0, x_k^i \ge 0, (U_k^i - \lambda(p_k + I + C'))x_k^i = 0$$

T_2 is the partial derivative of traveling cost with respect to x_k^f, and C' is the first derivative of the shipping fee with respect to x_k^i. λ is the Lagrange multiplier in this problem, and is interpreted as the marginal utility of income. If we assume that a consumer gains the same marginal utility from the good, regardless of whether it is purchased through his local jurisdiction stores, or from foreign jurisdiction stores, or from the Internet, the first partial derivatives of the utility function are the same. That is, $U_k^h=U_k^f=U_k^i$. Let U_k be the first partial derivative of the utility function.

When the consumer makes his decision about where to buy good k, the differences in effective prices across the different modes of purchase are taken into account. The consumer would buy good k in his local jurisdiction's retail stores if ($p_k + t_k^h$) were less than ($p_k + t_k^f + T_2$) and ($p_k + I + C'$). He would buy it in the foreign jurisdiction if ($p_k + t_k^f + T_2$) were less than ($p_k + t_k^h$) and ($p_k + I + C'$). He would buy it on the Internet if ($p_k + I + C'$) were less than ($p_k + t_k^h$) and ($p_k + t_k^f + T_2$).

If the sales-tax rate were high in the local jurisdiction, a resident would be less likely to buy good k in home-jurisdiction retail stores. He might buy good k in the foreign jurisdiction retail stores or over the Internet. If he is very risk averse, that is, if he hates revealing his credit-card number, he would be more likely to buy good k in the foreign jurisdiction than over the Internet. If the shipping fee were very high, he would also be more likely to buy good k in the foreign jurisdiction rather than over the Internet. If the traveling costs were very expensive, he would be more likely to purchase over the Internet.

If the consumer lives in a jurisdiction adjoining some other local jurisdictions with lower sales-tax rates, he is more likely to prefer buying the good k in the foreign state or county, rather than on the Internet. However, if he does not live in a county adjoining some other local jurisdictions with lower sales-tax rates, he would be more likely to purchase goods over the Internet. Thus, the consumer's geographic characteristics have an effect on his purchasing behavior.[12]

[12] In the original problem, I include the distance as a geographic variable, but it is very difficult in practice to use the distance as a geographic variable. The data set only provides very rough information about the location of residents-which state and county they live in. Thus, distance between the home county and the foreign county would be measured with considerable error, and I choose not to include it as an explanatory variable.

1.3. Empirical Analysis

1.3.1. Introduction

I analyze the data by county to focus on group effects.[13] Since there are some group effects, which cannot be explained explicitly, we have to capture the specific characteristics of counties. For example, some governments depend heavily on general sales taxes, but others do not. In order to capture the effects of different characteristics of all jurisdictions, I use group dummies and fixed-effects estimation.

State governments differ in how they enforce the collection of the sales and use tax. Nevada, South Dakota, Texas, and Washington do not have either a state individual income tax or a state corporate income tax, so their counties depend relatively heavily on the sales and use tax for their budgets.[14] These states may enforce the sales and use tax strongly, which may give these states' residents an incentive to rely on online businesses.

Some states rely heavily on the general sales tax, but others do not. Florida, Nevada, South Dakota, Tennessee, Texas, and Washington have ratios of general sales tax revenues to total tax revenues of 49% or more. Nevada. South Dakota, Texas, and Washington do not have state individual and corporate income taxes.[15] Florida and Tennessee do not have a state individual income tax. Therefore, these states must rely heavily on the sales tax for financing their expenditures. Differences in the importance of the sales tax may lead to differences in the degree of enforcement of the sales tax.

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[13] The analysis could be carried on at the state level, rather than at the county level. However, this would make it impossible to study cross-border shopping in the desired way. Virtually all residents of the United States are close to a county boundary. However, many are relatively far from the nearest state border.

[14] The average ratio of general sales taxes to total taxes in all state governments is about 30 percent, but the ratios in Nevada, Texas, and Washington are above 50%.

[15] I get information about state finance structures from http://taxfoundation.org/statefinance.html.

Even counties in the same state have different atmospheres. Some counties have well-equipped Internet infrastructures, and other do not. Generally, the counties in large metropolitan areas have well-equipped Internet background, and their residents would be more likely to use Internet shopping, all else equal. Macomb County, Michigan, is a suburban region of the Detroit metropolitan area, and its residents may be more likely to use Internet shopping than those in other counties in the state, such as Schoolcraft County, which is geographically more distant from major metropolitan areas.

I include group effects in the regression analysis to capture the effects mentioned above. I estimate the effects of sales-tax rates and consumers' geographic characteristics on Internet purchases at the county level.

1.3.2. Model Specification and Data

1.3.2.1. Data

I use CPS (Current Population Survey) data for 1997 and 2001.[16] The Current Population Survey (CPS) is a monthly survey of about 50,000 households conducted by the Bureau of the Census for the Bureau of Labor Statistics. The data contain information for each individual, such as household income, gender, race, education level, age, and marital status. The data set provides information on the geographic location of each individual, as well as whether she or he purchases goods over the Internet. The complete sample includes 266,160 observations, but many of these are not usable for the econometric analysis.

[16] http://www.bls.census.gov/cps/cpsmain.htm

I select only those individuals who have access to the Internet, because, if I were to use the whole data set, the estimates could suffer from serious sample-selection bias. That is, for some people who do not purchase goods over the Internet, the reason is that they do not have computers in their homes, or do not have access to the Internet by themselves. These people cannot purchase goods over the Internet because they do not have infrastructure to access the Internet. They have to buy goods at their "brick-and-mortar" stores, even if the sales-tax rates are very high. The factor that influences their consumption behavior is not a sales-tax rate or any demographic and geographic variable, but the infrastructure of Internet access. Therefore, I choose the individuals who have Internet access, and analyze them at the county level. Since I exclude those who do not have Internet access, I lose many observations. The sample that remains after excluding those without Internet access consists of 91,227 observations.

In addition, the CPS data do not report the county names for all individuals. I cannot identify the exact county names of some individuals, so I cannot find the exact sales-tax rates of those people. I also exclude those for whom county of residence is not available. After excluding those without Internet access as well as those for whom the county could not be identified, the sample is reduced to 35,667 observations.

Education level and marital status are important explanatory variables. However, these variables are not available for everyone in the sample. The CPS reports the education level and marital status only for those who are 15 years old or older. Therefore, I also exclude those who are less than 15 years old. After excluding those without Internet access, those for whom the county could not be identified, and those younger than 15 years, the sample is reduced to 30,911 observations.

The dependent variable is a binary variable, measuring whether the individual engages in online purchases. In other words, if the consumer buys goods online, the dependent variable is one; if not, it is zero.[17] I use household income, gender, race, marital status, education level, age, and the number of computers in a household as explanatory variables.

The key explanatory variables are the sales-tax rate and the geographic variables. The sales-tax rate at the county level is a weighted average sales-tax rate, based on the population ratios of cities and towns to the county. Sales-tax rates are measured in percentage points.

The states fall into four categories, with respect to the way in which they impose a retail sales tax.[18] First, Delaware, Montana, New Hampshire, and Oregon[19] do not impose sales tax on purchasing goods. Second, some states impose a uniform sales-tax rate.[20] In these cases, I do not need to calculate a weighted average sales-tax rate.

Third, there are some states with variations of sales-tax rates across counties, but no variation within each county (Florida, Georgia, Nevada, North Carolina, Pennsylvania, South Carolina, Wisconsin, and Wyoming). For these states, I do not need to calculate a weighted average sales-tax rate at the county level.

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[17] This variable has some weaknesses-it would be better if we knew not just whether they use the Internet for purchases, but how much they spend in online purchases. In this data set, a person who spends $10 per year via Internet is treated as identical to one who spends $1000 per year.

[18] Some 45 states and Washington D.C., impose general sales taxes, and 34 states allow their local governments to impose their own sales taxes (Cornia *et al.*, 2000)

[19] Alaska does not have a general sales tax, but its municipalities and counties impose their own sales taxes.

[20] They are Hawaii (4%), Virginia (4.5%), Indiana (5%), Maine (5%), Maryland (5%), Massachusetts (5%), Vermont (5%), the District of Columbia (5.75%), Connecticut (6%), Kentucky (6%), Michigan (6%), West Virginia (6%), Mississippi (7%), and Rhode Island (7%). Mississippi has a uniform sales-tax rate (7%), but only the city of Tupelo has its own general retail sales tax of 0.25%, which makes its sales-tax rate 7.25%.

Fourth, in some states, there are variations in sales-tax rates, both across counties and within counties. That is, cities within the same county have different sales-tax rates.[21] In this case, I calculate a weighted average sales-tax rate at the county level. I calculate the population ratio of each city to the county, and then multiply the population ratio of each city by the city's sales-tax rate. The weighted sum of the cities' sales-tax rates is a weighted average sales-tax rate for the county. In other words, the weighted average sales-tax rate for county j is defined as

$$\overline{t_j} = \sum_h t_{jh} \frac{p_{jh}}{p_j} \tag{1.4}$$

where

$\overline{t_j}$: weighted average sales - tax rate of county j,

t_{jh} : sales - tax rate for city h in county j,

p_{jh} : population of city h in county j, and

p_j : population of county j.

The other important explanatory variables are geographic variables, such as the tax differentials between the home jurisdiction and adjoining jurisdictions, and the sales-tax ratios of the home jurisdiction to the adjoining jurisdictions.

The tax differential is equal to the sales-tax rate of the home jurisdiction, minus the minimum sales-tax rate of all adjoining local jurisdictions. The variable is measured in percentage points, and it can be positive, zero, or negative if the sales-tax rate of a consumer's own jurisdiction is above, equal, or below the sales-tax rates of neighboring

[21] They are Alabama, Alaska, Arizona, Arkansas, California, Colorado, Idaho, Illinois, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Texas, Utah, and Washington.

jurisdictions. The sales-tax ratio of the home jurisdiction to the adjoining jurisdiction is (1+ the sales-tax rate of home jurisdiction)/(1+the minimum sales-tax rate of adjoining local jurisdictions).[22] I include these geographic variables in separate equations because they are closely related to each other. If I were to include them all together in the same regression, the estimates could suffer from multicollinearity.

These geographic variables are included in an attempt to learn about the patterns of cross-border shopping. The theoretical model presented earlier suggests that the distance between jurisdictions could have an important effect on cross-border shopping behavior. The geographic variables are only a rough proxy for distance. These variables are constructed by comparing the tax rate in the consumer's home jurisdiction with the lowest tax rate in any of the adjoining jurisdictions. Thus, it is possible that this specification misses certain aspects of cross-border shopping. For instance, it is possible that a consumer may engage in cross-border shopping by going two counties away, rather than by going to an adjoining county. Also, we treat everyone in a given county the same, regardless of whether they live just next to the county line, or miles away. This may be especially important in some western states, where the counties are very large. Therefore, it should be understood that the geographic variables are not perfect. However, it can certainly be argued that these variables allow us to study cross-border shopping in a way that is not possible in the model used by Goolsbee (2000). This is because Goolsbee assumed that everyone in a given metropolitan area faces the sales-tax rate that is used in the central city of that metropolitan area.

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[22]If I were to use (home jurisdiction sales-tax rate/adjoining jurisdiction sales-tax rate) as a tax ratio, the tax ratio might be undefined in some cases, because some states do not have general sales taxes.

Table 1.1 presents summary statistics for all variables at the county level. The sales-tax rate at the county level (*taxrate*) is a weighted average sales-tax rate based on the sales-tax rates of the various cities and towns in the county, with weights determined by population shares. Every sales-tax rate is measured in percentage points. For the sample as a whole, the average sales-tax rate is above 6 percent. Tax differential (*taxdiff*) is the difference between the sales-tax rates in the consumer's home jurisdiction and neighboring jurisdictions. I subtract the minimum sales-tax rate of all neighboring counties from the sales-tax rate of the consumer's home county. For example, Allegheny County, Pennsylvania has a 7% sales-tax rate in 2001, but adjoining counties in Pennsylvania have a 6% sales-tax rate. Therefore, the tax differential is 1 for a resident of Allegheny County.

The sales-tax ratio is $(1+t_h)/(1+t_f)$, where t_h is the sales-tax rate of the home jurisdiction and t_f is the minimum sales-tax rate among all neighboring jurisdictions. The residents of Washington, D.C., could buy goods at retail stores in counties of Maryland and Virginia, as well as in Washington, D.C. The sales-tax rates in D.C., Maryland, and Virginia are 5.75%, 5%, and 4.5%, so the residents in Washington, D.C., would have an incentive to buy goods in Virginia. The sales-tax ratio (*taxratio*) for a D.C. resident is (1+0.0575)/(1+0.045), which equals 1.0120. Consumers who live in local jurisdictions with higher sales-tax rates have sales-tax ratios which are greater than 1. Those who live in a county with the same sales-tax rate as the sales-tax rates of neighboring counties have sales-tax ratios which are equal to 1. Those who live in a county with lower sales-tax rates have sales-tax ratios which are less than 1. Summary information key variable is given in Table 1.1, for those consumers who are included in the sample.

Table 1.1 Summary Statistics (county level)

	All individuals	Buyers	Non-buyers
N	24,804	10,500	14,304
taxrate (%)	6.2815 (1.9361)	6.2237 (1.9742)	6.3239 (1.9066)
Taxdiff	.6958 (1.5142)	.7255 (1.5532)	.6741 (1.4845)
Taxratio	1.0066 (.0148)	1.0069 (.0152)	1.0064 (.0145)
Household income	58,950.42 (22,930.92)	61,990.83 (21,916.30)	56,718.58 (23,398.66)
Female	.4973 (.5000)	.4986 (.5000)	.4964 (.5000)
White	.8465 (.3605)	.8637 (.3431)	.8339 (.3722)
Married	.5833 (.4930)	.6160 (.4864)	.5594 (.4965)
Education	14.52 (2.8576)	15.03 (2.7626)	14.14 (2.8676)
# of computers	1.4701 (.6939)	1.5844 (.7483)	1.3863 (.6382)
Age	38.51 (14.48)	39.16 (13.11)	38.03 (15.40)

The numbers in parentheses are standard deviations. The household income is measured in dollars. Education and age are measured in years.

1.3.2.2. Model Specification

I use fixed-effects estimation to capture the group-specific effects of sales-tax rates and geographic features. The main model is

$$
\begin{aligned}
y_{ij} = {} & \beta_0 + \beta_1 taxrate_{ij} + \beta_2 geo_{ij} + \beta_3 lincome_{ij} + \beta_4 female_{ij} + \beta_5 white_{ij} + \beta_6 married_{ij} \\
& + \beta_7 femared_{ij} + \beta_8 whmared_{ij} + \beta_9 fewhite_{ij} + \beta_{10} fewhmar_{ij} + \beta_{11} highgrad_{ij} \\
& + \beta_{12} colgrad_{ij} + \beta_{13} prograd_{ij} + \beta_{14} nch_{ij} + \beta_{15} age15_{ij} + \beta_{16} age20_{ij} + \beta_{17} age30_{ij} + \\
& \beta_{18} age50_{ij} + \beta_{19} age60_{ij} + \beta_{20} d01 + a_i + u_{ij} \qquad (1.5)
\end{aligned}
$$

where

$femared = female \times married$

$whmared = white \times married$

$fewhite = female \times white$

$fewhmar = female \times white \times married$

The *i* subscripts refer to the local jurisdiction, that is, county. The *j* subscripts refer to the individual consumer in county *i*. The dependent variable, *y*, is whether a consumer purchases goods over the Internet. *taxrate* is the weighted average sales-tax rate in the county in which a consumer lives. *geo* includes the geographic variables for the consumer. It includes *taxdiff* and *taxratio* at the county level. *taxdiff* is the tax differential between the sales-tax rate of the consumer's home county and the minimum sales-tax rate of his neighboring counties. *taxratio* is the sales-tax ratio of the individual's home county to the adjoining county with the lowest sales-tax rate.

lincome is the log of the resident's household income. This variable is included for several reasons. First, *lincome* may be viewed as a proxy for aspects of human capital that are not captured by other variables, such as education and age. Second, *lincome* may be a proxy for the opportunity cost of time. In this respect, it would be valuable to use data on wage rates, rather than income data. However, for a substantial portion of the sample, wage rate data are not available.

female, *white*, and *married* are all binary variables to explain the individual's demographic features.[23] *femared* is an interaction term of *female* and *married*, and *whmared* is also an interaction term of *white* and *married*. *fewhite* is an interaction of *female* and *white*, and *fewhmar* is an interaction term of *female*, *white*, and *married*. *highgrad*, *colgrad*, and *prograd* are all education-dummy variables. If an individual has graduated from high school, *highgrad* is 1, or 0 if not. If a consumer has graduated from college, *colgrad* is 1. If an individual has received an MA, Ph.D, or professional degree, *prograd* is 1. *nch* is the number of computers in the household, which represents the Internet infrastructure of a consumer. *age15, age20, age30, age50,* and *age60*[24] are age-group-dummy variables, and consumers in their 40s are a base group. *d01* is a yearly dummy variable, and is one when an observation is taken in 2001. If it is taken in 1997, it is zero. a_i is the group-specific effect of a county and u_{ij} is an error term.

[23] If a consumer is female, *female* is 1, otherwise 0. If she is married and white, *married* and *white* are equal to 1.

[24] *age15* is 1 if a consumer's age is from 15 to 19, *age20* is 1 if her age is from 20 to 29, and *age60* is 1 if her age is greater than or equal to 60.

As mentioned earlier, I use fixed-effects estimation to capture the unobserved group-specific effects of counties. Fixed-effects estimation can consider the specific and inborn effects of counties, and capture the characteristics within a group as well as across groups.[25]

We shall see that the results for the tax variables are somewhat sensitive with respect to the size of the metropolitan areas from the observations are chosen. This may be because large metropolitan areas have better developed transportation systems, which facilitate cross-border shopping. The large metropolitan areas may also have different Internet infrastructure or different attitudes toward tax evasion, which may lead to different degrees of responsiveness to tax rates. Thus, to begin with, I report the estimation results for the entire sample. After that, I restrict the sample to those who live in metropolitan areas whose populations are above one, two, and three million, and estimate them separately. Finally, I will compare the estimation results of metropolitan areas with population limits with that of the whole sample.

1.3.3. Empirical Analysis

1.3.3.1. Empirical Analysis Without Population Limits

In this subsection, I analyze the effects of sales-tax rates and geographic variables on online purchases when I use all observations. Table 1.2 shows the effects of demographic and geographic variables on online purchases if I use all observations. Table 1.2

[25] The explanatory variables should be related to group effects. Therefore, fixed-effects estimation is more appropriate for this model than random-effects estimation. In order to check this, I use Hausman specification test.

describes the results of fixed-effects estimation with robust standard errors at the county level. The first column is the estimation result when I include the sales-tax differential (*taxdiff*) as a geographic variable, and the second column is the result with the sales-tax ratio (*taxratio*). I report the robust standard errors adjusted for cluster sampling (Wooldridge, 2001), allowing that the observations are independent across counties (clusters), but not necessarily independent within counties (clusters). In this analysis, the sales-tax rate (*taxrate*) coefficient is positive, but is not significant in either specification. A consumer who lives in a county with a high sales-tax rate would be more likely to make online purchases, all else equal. When the sales-tax rate increases by one percentage point, all other variables held constant, the probability that a consumer would make online purchases will increase by 0.41% if I include *taxdiff* in the model. When *taxratio* is used as a geographic variable, the probability will increase by 0.42% if *taxrate* increases by one percentage point.

The coefficients on the geographic variables are all positive, which is contrary to my expectation, and *taxdiff* and *taxratio* are not statistically significant in separate regressions. When I use all observations, the coefficient estimates of the geographic variables do not give strong results.

The coefficient estimate of *lincome* is positive and statistically significant in both regressions. When a consumer's income increases by 1%, the probability that she would make online purchases will increase by .0003 (.03%).[26]

26

$\frac{\beta}{100} = \frac{\Delta y}{\%\Delta income}$, which means that y is increasing by $\beta/100$ when income increases by 1%.

Table 1.2 Fixed-Effects Estimation (No Population Limit)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.0041	0.0042
	(0.0313)	(0.0306)
Taxdiff	0.0059	
	(0.0448)	
Taxratio		0.6503
		(4.4428)
Lincome	0.0326***	0.0321***
	(0.0064)	(0.0064)
Female	-0.0496***	-0.0496***
	(0.0169)	(0.0170)
White	0.0736***	0.0739***
	(0.0209)	(0.0209)
Married	-0.0320	-0.0318
	(0.0235)	(0.0235)
Femared	0.0166	0.0166
	(0.0225)	(0.0226)
Whmared	0.0029	0.0027
	(0.0245)	(0.0245)
Fewhite	0.0261	0.0259
	(0.0204)	(0.0205)
Fewhmar	0.0183	0.0185
	(0.0283)	(0.0283)
Highgrad	0.0783***	0.0776***
	(0.0132)	(0.0132)
Colgrad	0.1007***	0.1003***
	(0.0078)	(0.0078)
Prograd	0.0127	0.0129
	(0.0117)	(0.0117)
Nch	0.0837***	0.0835***
	(0.0053)	(0.0053)
Age15	-0.1161***	-0.1166***
	(0.0160)	(0.0160)
Age20	0.0100	0.0101
	(0.0105)	(0.0105)
Age30	0.0453***	0.0460***
	(0.0089)	(0.0089)
Age50	-0.0251***	-0.0260***
	(0.0093)	(0.0093)
Age60	-0.1196***	-0.1194***
	(0.0137)	(0.0138)
D01	0.3760***	0.3761***
	(0.0119)	(0.0119)
N	24,804	24,804
# of groups	215	215
R^2	0.1740	0.1740
Tax Elasticity	0.0612	0.0627

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

The partial effect of *female* is -.0496 + .0166 $\times$ *married* + .0261 $\times$ *white* + .0183 $\times$ *white* $\times$ *married* if a consumer is female. In the case of *white*, its partial effect is roughly .0736 + .0029 $\times$ *married* + .0261 $\times$ *female* + .0183 $\times$ *female* $\times$ *married.* The partial effect of *married* is -.0320 + .0166 $\times$ *female* + .0029 $\times$ *white* + .0183 $\times$ *female* $\times$ *white.*

This estimation equation implies that education-dummy variables have positive effects on online purchases. These coefficients for *highgrad* and *colgrad* are statistically significant. The coefficient estimate of *nch* is positive and statistically significant in both regressions. If a consumer owns one more computer at her household, the probability of online purchases is predicted to increase by about 8%. The *age* dummy variables have different signs and coefficient estimates. Compared to consumers in their 40s, consumers from 15 to 19 and those in their 50s and 60s would be less likely to make online purchases. Teenage people generally do not have credit cards which are necessary to online purchases, and old people prefer general retail shopping to online shopping. Old people may have greater concern about revealing their credit card numbers over the Internet, and a strong preference for inspecting goods before purchasing. Consumer in their 20s and 30s prefer e-commerce, compared to people in their 40s. The age-group dummy variables are statistically significant, except for age 20.

The yearly dummy variable, *d01*, is positive and statistically significant, which explains the current trend. Year to year, more consumers engage in e-commerce, and the number of transactions in e-commerce is increasing. The tax elasticities[27] in the model are .0612 and .0627 respectively. If the tax elasticity were very large, the state or local governments would lose their sales-tax revenues when they increase their sales-tax rates.

1.3.3.2. Empirical Analysis with Population Limits

In this subsection, I analyze the effects of sales-tax rates and geographic variables on online purchases when I place some restrictions on the sample. I choose observations for those in metropolitan areas with populations of at least one million, two million, and three million. Table 1.4, Table 1.5, and Table 1.6 show the effects of demographic and geographic variables on online purchases when I use different population limits. I use fixed-effects estimation at the county level,[28] and choose metropolitan areas whose populations are more than one, two, and three million. The first column in each table is the estimation result when I include the sales-tax differential (*taxdiff*) as a geographic variable, and the second column is the result with the sales-tax ratio (*taxratio*).

Unlike the estimation results without a population limit, these estimation results with population limits provide expected signs and significant coefficients for the sales-tax rate (*taxrate*), the sales-tax differential (*taxdiff*), and the sales-tax ratio (*taxratio*). The

---

[27] The tax elasticity is defined as $\frac{\partial y}{\partial taxrate}\frac{taxrate}{y}$. The weakness of my measure of the tax elasticity is that I use a binary variable for y. Ideally, y should be how much a consumer purchases online, to measure the tax elasticity correctly. However, this information is not available in my data set, and I use this binary data for the tax elasticity.

[28] Fixed-effects estimation assumes that the unobserved effect (a_i) is correlated with each explanatory variable. Random-effects estimation assumes that the group specific effect (a_i) is uncorrelated with each explanatory variable. We can use the Hausman test to determine which estimation method is appropriate. According to the Hausman test, random-effects estimation is inconsistent, but fixed-effects estimation is consistent. Therefore, fixed-effects estimation is more appropriate for this model than random-effects estimation (Wooldridge, 2001).

coefficient estimates of *taxrate* in all population limit cases have positive signs, and they are significant, marginally significant, and insignificant in the three million, two million, and one million case respectively. When the population limits increase, the coefficient estimates and t-statistics of *taxrate* increase together. All coefficient estimates of *taxdiff* are negative, and they are statistically significant in the cases of one and two-million population limits. The coefficient estimates of *taxratio* are negative in all cases, and they are statistically significant except for the three-million case. Thus, for the large metropolitan areas, the sales-tax rate and geographic variables are influential factors in determining consumers' shopping patterns.

Let me explain the effect of each variable in the case of the two-million population limit (Table 1.5). The coefficient estimate of *taxrate* is about .0581, which means that the probability that a consumer makes online purchases is predicted to increase by 5.81% when the sales-tax rate increases by one percentage point. The tables show that the coefficient estimates of *taxrate* are increasing when the population limit increases. These results indicate that, in large metropolitan areas, the sales-tax rate is expected to be an important factor in consumers' purchasing patterns. The effects become more pronounced when we consider those in very large metropolitan areas.

Table 1.5 (two-million case) shows that the coefficient estimate of *taxdiff* is -.0930, and is statistically significant at the 1% level. If the tax rate of a consumer's home jurisdiction is above that of her neighbor's jurisdiction by one percentage point, the probability that she makes online purchases is predicted to decrease by 9.30%. I interpret this as meaning that a consumer would prefer cross-border shopping to Internet shopping when the tax-rate differential increases. The coefficient estimate of *taxratio* is negative and statistically significant at the 1% level in Table 1.5 (two-million case). It explains that the sales-tax ratio as a geographic variable plays a significant role in e-commerce. The interpretation of *taxratio* is similar to the interpretation of *taxdiff*.

The coefficient estimates of *lincome* are positive and statistically significant in all regressions. Table 1.5 (two-million case) implies that the probability that she would make online purchases will increase by about .000291 (.0291%) when a consumer's income increases by 1%.

The partial effect of *female* is -.0396 + .0166×*married* + .0182×*white* + .0291×*white*×*married*. In the case of *white*, its partial effect is roughly .0583 + .0128×*married* + .0182×*female* + .0291×*female*×*married*. The partial effect of *married* is -.0603 + .0166×*female* + .0128×*white* +. 0291×*female*×*white*.

Table 1.3 The Partial Effects of Group-Dummy Variables

Base Group: the unmarried, nonwhite, and male	
the unmarried, nonwhite, and female	-0.0396
the unmarried, white, and male	0.0583
the married, nonwhite, and male	-0.0603
the unmarried, white, and female	0.0162
the married, nonwhite, and female	-0.0833
the married, white, and male	0.0108
the married, white, and female	0.0351

For the purpose of comparisons of some dummy variables and interactions terms, I call the unmarried, nonwhite, and male a base group. The unmarried, nonwhite, and female would be less likely to make online purchases than the base group by 3.96%, the unmarried, white and male would be more engaged in Internet shopping by 5.83%, and the married, nonwhite, and male would be less likely to use Internet shopping by 6.03%. If I interpret the interaction terms, the unmarried, white, and female would be more engaged in e-commerce than the base group by 1.62%, the married, nonwhite, and female would be less likely to make online purchases by 8.33%, and the married, white, and male would be more engaged in Internet shopping by 1.08%. The married, white, and female would be more likely to make online purchases by 3.51%. The results are shown in Table 1.3.

Table 1.5 (two million case) implies that all education-dummy variables have positive effects on online purchases. The coefficient estimate of *nch* is positive and statistically significant in all regressions. Not surprisingly, if a consumer owns one more computer at her household, she would be more likely to make online purchases. The *age* dummy variables indicate that the likelihood of Internet shopping will increase with age until the consumer is in her 30s. After that, increasing age is associated with declining use of the Internet for purchases. Compared to consumers in their 40s, consumers from age 15 to age 19 and those in their 50s and 60s would be less likely to make online purchases. Teenage people generally do not have credit cards which are necessary for online purchases, and old people prefer general retail shopping to online shopping. Old people may have greater concern about revealing their credit card numbers over the Internet, and a strong preference for inspecting goods before purchasing. Consumers in their 20s and 30s prefer e-commerce, compared to people in their 40s. Except for the age-group dummy for the 20s, the age-group dummy variables are statistically significant.

The yearly dummy variable, *d01*, is positive and statistically significant, which explains the current trend. Recently, the number of consumers who engage in e-commerce has increased dramatically.

If I compare the rich ($80,000), white, unmarried, male who graduates from a college with the poor ($8,000), black, unmarried, female who drops out of high school, the former person would be more likely to make online purchases than the latter person by 33.85%.

The tax elasticities in the model are increasing when I increase the population limit. When I choose metropolitan areas whose population is above three million, the tax elasticity is above 4 in both regressions. This means that consumers would be more likely to depend on Internet shopping when their local governments try to increase their tax rates. In large metropolitan areas, state and local governments would lose their sales-tax revenues severely by way of online commerce.

In conclusion, when I restrict the sample and choose only those observations from metropolitan areas whose populations are more than one, two, and three million, the sales-tax rate (*taxrate*) is positive and statistically significant. If I increase the population limit, the estimated coefficient increases. Consumers who live in metropolitan areas with a lot of population are very sensitive to the sales-tax rate in making online purchases. They also consider geographic variables such as the sales tax-rate differential (*taxdiff*) and the sales-tax ratio (*taxratio*), when deciding whether to make online purchases. When her own jurisdiction has a higher sales-tax rate than adjoining jurisdictions, a consumer would be less likely to engage online businesses. I interpret this as evidence that the consumer would prefer cross-border shopping to online shopping, because of the sales tax-rate gap between her own jurisdiction and the neighboring jurisdiction. In other words, when this tax-rate gap dominates transportation costs which are engaged in cross-border shopping, consumers would have an incentive to purchase goods in retail markets in neighboring jurisdictions, instead of making online purchases.

Table 1.4 Fixed-Effects Estimation (Population Limit=1,000,000)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.0282	0.0285
	(0.0400)	(0.0383)
Taxdiff	-0.0705***	
	(0.0231)	
Taxratio		-9.8426***
		(2.2541)
Lincome	0.0364***	0.0364***
	(0.0078)	(0.0078)
Female	-0.0412**	-0.0410**
	(0.0189)	(0.0189)
White	0.0673***	0.0676***
	(0.0239)	(0.0240)
Married	-0.0455*	-0.0453*
	(0.0260)	(0.0260)
Femared	0.0100	0.0096
	(0.0263)	(0.0263)
Whmared	0.0008	0.0006
	(0.0248)	(0.0248)
Fewhite	0.0165	0.0164
	(0.0234)	(0.0234)
Fewhmar	0.0357	0.0361
	(0.0322)	(0.0322)
Highgrad	0.0771***	0.0770***
	(0.0163)	(0.0163)
Colgrad	0.1043***	0.1043***
	(0.0097)	(0.0097)
Prograd	0.0147	0.0147
	(0.0145)	(0.0146)
Nch	0.0855***	0.0855***
	(0.0065)	(0.0065)
Age15	-0.1276***	-0.1278***
	(0.0200)	(0.0199)
Age20	-0.0005	-0.0007
	(0.0122)	(0.0122)
Age30	0.0483***	0.0482***
	(0.0111)	(0.0111)
Age50	-0.0407***	-0.0407***
	(0.0106)	(0.0105)
Age60	-0.1155***	-0.1154***
	(0.0174)	(0.0174)
D01	0.3918***	0.3911***
	(0.0156)	(0.0155)
N	16,014	16,014
# of groups	107	107
R^2	0.1887	0.1888
Tax Elasticity	0.4553	0.4602

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

Table 1.5 Fixed-Effects Estimation (Population Limit=2,000,000)

	Dependent Variable: whether she or he makes online purchases	
Taxrate	0.0581	0.0570
	(0.0492)	(0.0495)
Taxdiff	-0.0930***	
	(0.0206)	
Taxratio		-9.5537***
		(2.0855)
Lincome	0.0291***	0.0291***
	(0.0091)	(0.0091)
Female	-0.0396*	-0.0396*
	(0.0206)	(0.0206)
White	0.0583**	0.0583**
	(0.0266)	(0.0266)
Married	-0.0603**	-0.0604**
	(0.0275)	(0.0275)
Femared	0.0166	0.0166
	(0.0309)	(0.0309)
Whmared	0.0128	0.0128
	(0.0258)	(0.0258)
Fewhite	0.0182	0.0182
	(0.0264)	(0.0264)
Fewhmar	0.0291	0.0291
	(0.0384)	(0.0384)
Highgrad	0.0800***	0.0800***
	(0.0167)	(0.0167)
Colgrad	0.1136***	0.1136***
	(0.0106)	(0.0106)
Prograd	0.0325**	0.0325**
	(0.0150)	(0.0150)
Nch	0.0888***	0.0888***
	(0.0076)	(0.0076)
Age15	-0.1099***	-0.1099***
	(0.0245)	(0.0245)
Age20	0.0023	0.0023
	(0.0149)	(0.0149)
Age30	0.0504***	0.0504***
	(0.0130)	(0.0130)
Age50	-0.0439***	-0.0439***
	(0.0125)	(0.0125)
Age60	-0.1212***	-0.1212***
	(0.0195)	(0.0195)
D01	0.3947***	0.3946***
	(0.0207)	(0.0207)
N	11,341	11,341
# of groups	69	69
R^2	0.1898	0.1898
Tax Elasticity	0.9208	0.9034

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

Table 1.6 Fixed-Effects Estimation (Population Limit=3,000,000)

	Dependent Variable: whether she or he makes online purchases	
Taxrate	0.2849**	0.2851**
	(0.1187)	(0.1185)
Taxdiff	-0.0243	
	(0.0394)	
Taxratio		-2.5238
		(4.0614)
Lincome	0.0293**	0.0293**
	(0.0118)	(0.0118)
Female	-0.0420*	-0.0420*
	(0.0225)	(0.0225)
White	0.0298	0.0298
	(0.0267)	(0.0267)
Married	-0.0767***	-0.0767***
	(0.0296)	(0.0296)
Femared	0.0329	0.0329
	(0.0381)	(0.0381)
Whmared	0.0283	0.0283
	(0.0325)	(0.0325)
Fewhite	0.0235	0.0235
	(0.0363)	(0.0363)
Fewhmar	0.0163	0.0163
	(0.0548)	(0.0548)
Highgrad	0.0777***	0.0777***
	(0.0199)	(0.0199)
Colgrad	0.1171***	0.1171***
	(0.0134)	(0.0134)
Prograd	0.0408**	0.0408**
	(0.0207)	(0.0207)
Nch	0.0825***	0.0825***
	(0.0100)	(0.0100)
Age15	-0.1098***	-0.1098***
	(0.0331)	(0.0331)
Age20	0.0021	0.0021
	(0.0182)	(0.0182)
Age30	0.0638***	0.0638***
	(0.0165)	(0.0165)
Age50	-0.0402**	-0.0402**
	(0.0159)	(0.0159)
Age60	-0.1196***	-0.1196***
	(0.0285)	(0.0285)
D01	0.4268***	0.4269***
	(0.0352)	(0.0351)
N	6,087	6,087
# of groups	31	31
R^2	0.1973	0.1973
Tax Elasticity	4.4416	4.4447

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

1.3.3.3. Probit Analysis

The dependent variable is a binary variable in this model, so I can use Probit estimation to grasp the characteristics of the dependent variable. In addition, I have to include the county-dummy variables in the Probit estimation, to find the innate trait of each county. Table 1.7, Table 1.8, and Table 1.9 show[29] the results of the Probit estimation at the county level, for consumers in metropolitan areas of various sizes.

The estimation results are very similar to those in the fixed-effects analysis. Like the estimation results in the fixed-effects analysis, the sales-tax rate (*taxrate*) is positive in all estimation results, and insignificant, marginally significant, and significant in the cases of the one-million, two-million, and three-million population limits respectively. When the population limits increase, the marginal effects and t-statistics of *taxrate* increase together. All marginal effects of *taxdiff* and *taxratio* are negative, and they are statistically significant in the cases of one- and two-million population limits. Thus, the sales-tax rate and geographic variables are influential factors in determining consumers' shopping patterns in the Probit analysis for large metropolitan areas, just as they were in the fixed-effects analysis. Other variables such as *lincome*, *female*, *white*, *married*, *edu*, *nch*, *d01* etc., have the same signs as in the fixed-effects analysis.

When I change my regression method from the fixed-effects estimation to the Probit estimation, the signs of the sales-tax rate (*taxrate*) and the geographic variables (*taxdiff* and *taxratio*) do not change, and their t-statistics do not change very much, either. These results support the results of the last subsection that *taxrate*, *taxdiff*, and *taxratio* play

[29] The estimates in Table 1.7, Table 1.8, and Table 1.9 are the marginal effects of explanatory variables.

major roles in determining consumers' purchasing patterns. As suggested by the results in the last subsection, a consumer would be more likely to make online purchases when she lives in a jurisdiction with a high sales-tax rate. In addition, even if she lives in a jurisdiction with a high sales-tax rate, a consumer would be less likely to make online purchases, as long as her jurisdiction adjoins other jurisdictions with lower sales-tax rates. These results suggest that residents of large metropolitan areas are reducing their sales-tax liabilities, both by evading taxes through Internet purchases, and by engaging in cross-border shopping.

Table 1.7 Probit Estimation (Population Limit=1,000,000)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.0448	0.0479
	(0.0529)	(0.0499)
Taxdiff	-0.0934**	
	(0.0404)	
Taxratio		-14.5611***
		(4.8225)
Lincome	0.0417***	0.0417***
	(0.0095)	(0.0095)
Female	-0.0414*	-0.0413*
	(0.0221)	(0.0221)
White	0.0787***	0.0789***
	(0.0263)	(0.0264)
Married	-0.0517*	-0.0516*
	(0.0303)	(0.0303)
Femared	0.0061	0.0057
	(0.0308)	(0.0308)
Whmared	-0.0008	-0.0009
	(0.0290)	(0.0291)
Fewhite	0.0117	0.0116
	(0.0280)	(0.0280)
Fewhmar	0.0474	0.0478
	(0.0384)	(0.0385)
Highgrad	0.0917***	0.0917***
	(0.0189)	(0.0189)
Colgrad	0.1161***	0.1161***
	(0.0111)	(0.0111)
Prograd	0.0189	0.0188
	(0.0172)	(0.0172)
Nch	0.0987***	0.0988***
	(0.0072)	(0.0072)
Age15	-0.1584***	-0.1585***
	(0.0212)	(0.0212)
Age20	-0.0023	-0.0025
	(0.0138)	(0.0138)
Age30	0.0556***	0.0555***
	(0.0131)	(0.0131)
Age50	-0.0481***	-0.0481***
	(0.0119)	(0.0119)
Age60	-0.1265***	-0.1264***
	(0.0180)	(0.0180)
D01	0.4030***	0.4025***
	(0.0121)	(0.0120)
N	16,013	16,013
Pseudo R^2	0.1564	0.1565

The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 1.8 Probit Estimation (Population Limit=2,000,000)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.0659	0.0646
	(0.0606)	(0.0609)
Taxdiff	-0.1199***	
	(0.0418)	
Taxratio		-12.3473***
		(4.2741)
Lincome	0.0340***	0.0340***
	(0.0114)	(0.0114)
Female	-0.0406*	-0.0407*
	(0.0238)	(0.0238)
White	0.0695**	0.0695**
	(0.0296)	(0.0296)
Married	-0.0705**	-0.0705**
	(0.0323)	(0.0323)
Femared	0.0144	0.0144
	(0.0357)	(0.0357)
Whmared	0.0138	0.0138
	(0.0304)	(0.0304)
Fewhite	0.0147	0.0147
	(0.0310)	(0.0310)
Fewhmar	0.0395	0.0395
	(0.0447)	(0.0447)
Highgrad	0.0950***	0.0950***
	(0.0200)	(0.0200)
Colgrad	0.1266***	0.1266***
	(0.0122)	(0.0122)
Prograd	0.0392**	0.0392**
	(0.0183)	(0.0183)
Nch	0.1030***	0.1030***
	(0.0086)	(0.0086)
Age15	-0.1394***	-0.1394***
	(0.0272)	(0.0272)
Age20	-0.0001	-0.0001
	(0.0168)	(0.0168)
Age30	0.0582***	0.0582***
	(0.0155)	(0.0155)
Age50	-0.0526***	-0.0526***
	(0.0143)	(0.0143)
Age60	-0.1338***	-0.1338***
	(0.0204)	(0.0204)
D01	0.4081***	0.4081***
	(0.0160)	(0.0160)
N	11,341	11,341
Pseudo R^2	0.1561	0.1560

The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 1.9 Probit Estimation (Population Limit=3,000,000)

	Dependent Variable: whether she or he makes online purchases	
Taxrate	0.2971*	0.2976*
	(0.1567)	(0.1564)
Taxdiff	-0.0843	
	(0.0779)	
Taxratio		-8.7982
		(8.0032)
Lincome	0.0346**	0.0346**
	(0.0148)	(0.0148)
Female	-0.0449*	-0.0449*
	(0.0251)	(0.0251)
White	0.0359	0.0359
	(0.0306)	(0.0306)
Married	-0.0949***	-0.0949***
	(0.0345)	(0.0345)
Femared	0.0363	0.0363
	(0.0431)	(0.0431)
Whmared	0.0350	0.0350
	(0.0394)	(0.0394)
Fewhite	0.0195	0.0194
	(0.0419)	(0.0419)
Fewhmar	0.0256	0.0256
	(0.0627)	(0.0627)
Highgrad	0.0894***	0.0894***
	(0.0231)	(0.0231)
Colgrad	0.1313***	0.1313***
	(0.0157)	(0.0157)
Prograd	0.0501*	0.0501*
	(0.0263)	(0.0263)
Nch	0.0974***	0.0974***
	(0.0114)	(0.0114)
Age15	-0.1429***	-0.1429***
	(0.0381)	(0.0381)
Age20	-0.0003	-0.0003
	(0.0207)	(0.0207)
Age30	0.0735***	0.0735***
	(0.0199)	(0.0199)
Age50	-0.0502***	-0.0502***
	(0.0188)	(0.0188)
Age60	-0.1293***	-0.1293***
	(0.0294)	(0.0294)
D01	0.4301***	0.4302***
	(0.0274)	(0.0274)
N	6,087	6,087
Pseudo R^2	0.1612	0.1612

The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

1.3.3.4. Empirical Analysis with Inflation level

In the regressions reported so far, there is no correction for price level, or for the inflation rate. Price-level data are available for certain metropolitan areas from ACCRA. However, these data are normalized within each year. Therefore, they do not allow a meaningful comparison across years, either for different metropolitan areas or for the same area. Consequently, it has not been possible to use price-level data. As an alternative, I include a measure of the rate of change of the price level. I include the percentage change in the Consumer Price Index (PCCPI) as an explanatory variable in this subsection. When the price levels in retail stores in a region are increasing very much, consumers have an incentive to find other shopping methods, such as mail-order shopping and Internet shopping. Therefore, I expect that inflation rates would have a positive effect on Internet shopping. Thus, if inflation rates are not included, the estimated coefficients may suffer from omitted-variable problems. In order to compare the inflation rates in different regions, I use percentage changes in the Consumer Price Index (*pccpi*) as a proxy variable.[30]

In the preceding paragraph, I argued that price-level data might be superior to inflation data. However, there is a theoretical argument that could be advanced in favor of the *pccpi* variable. If we adopt a model with habit formation, it is possible that a sudden jump in prices could cause consumers to become more sensitive to economic variables than they had been previously. In a model such as this, the inflation rate might

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[30] $pccpi=(cpi_t-cpi_{t-1})\times 100/cpi_{t-1}$

be more appropriate than the price level. In any event, the decision to use *pccpi* is driven largely by data availability.

The subsection 1.3.3.1 and 1.3.3.2 show that the sales-tax rate (*taxrate*) and the geographic variables (*taxdiff* and *taxratio*) have expected signs and significant results when I restrict the sample and choose only those observations from big metropolitan areas. The Bureau of Labor Statistics[31] reports the Consumer Price Index (CPI) for 26 metropolitan areas annually. There are large metropolitan areas, such as Chicago, Detroit, Los Angeles, New York, Philadelphia, and San Francisco. Thus, if I include the percentage change in the Consumer Price Index (*pccpi*) as an explanatory variable, automatically I choose observations for those in big metropolitan areas. After that, I can compare the results of this model specification with the results of population limits in the previous subsections.

I use the fixed-effects estimation at the county level. At first, I do not place a population-limit restriction on the sample, and then I restrict the sample to metropolitan areas with population limits such as one, two, and three million. Table 1.10 shows the estimation results without population limits when I include *pccpi* as an explanatory variable. Table 1.11, Table 1.12, and Table 1.13 show the estimation results with *pccpi* when I place one-, two-, and three-million population limits on the sample.

Table 1.10 (No Population limit) shows that the coefficient estimate of the sales-tax rate (*taxrate*) has a positive sign and a significant t-statistic and that the coefficient estimates of the geographic variables (*taxdiff* and *taxratio*) also have expected signs (negative signs) and significant t-statistics. The estimation results support the results of the previous subsections, in which population limits are placed on the sample without

[31] CPIs for metropolitan areas are available from http://www.bls.gov/cpi/home.htm.

pccpi. The coefficient estimate of the percentage change in the Consumer Price Index (*pccpi*) has a positive sign, and is statistically significant. It implies that the consumers who live in the metropolitan areas with high inflation rates would be likely to engage in online commerce. Other variables have similar results as in the previous subsections.

When I use population limits such as one, two, and three million, Table 1.11, Table 1.12, and Table 1.13 show that the sales-tax rate (*taxrate*) has a positive sign and its coefficients are statistically significant. The geographic variables (*taxdiff* and *taxratio*) are negative, and their coefficient estimates are significant except for the three million case. *pccpi* are positive, and its coefficient estimates are significant except for the three million case too. All estimation results strengthen the results of the previous subsections, and support the evidence that the inflation rate is an influential factor in e-commerce.

Table 1.10 Fixed-Effects Estimation (No Population Limit & *Pccpi*)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.2080**	0.1933**
	(0.0946)	(0.0927)
Taxdiff	-0.0756***	
	(0.0269)	
Taxratio		-7.8194***
		(2.7479)
Pccpi	0.0436**	0.0419*
	(0.0214)	(0.0219)
Lincome	0.0355***	0.0354***
	(0.0083)	(0.0083)
Female	-0.0460***	-0.0461***
	(0.0178)	(0.0178)
White	0.0713***	0.0714***
	(0.0242)	(0.0243)
Married	-0.0357	-0.0356
	(0.0256)	(0.0256)
Femared	0.0106	0.0105
	(0.0232)	(0.0233)
Whmared	0.0041	0.0041
	(0.0272)	(0.0272)
Fewhite	0.0246	0.0246
	(0.0225)	(0.0225)
Fewhmar	0.0237	0.0239
	(0.0308)	(0.0308)
Highgrad	0.0749***	0.0748***
	(0.0165)	(0.0165)
Colgrad	0.0961***	0.0961***
	(0.0093)	(0.0093)
Prograd	0.0247*	0.0248*
	(0.0132)	(0.0132)
Nch	0.0822***	0.0822***
	(0.0065)	(0.0065)
Age15	-0.1065***	-0.1065***
	(0.0202)	(0.0202)
Age20	0.0116	0.0117
	(0.0127)	(0.0127)
Age30	0.0438***	0.0438***
	(0.0115)	(0.0115)
Age50	-0.0417***	-0.0416***
	(0.0105)	(0.0105)
Age60	-0.1147***	-0.1146***
	(0.0168)	(0.0168)
D01	0.3594***	0.3598***
	(0.0241)	(0.0243)
N	16,188	16,188
# of groups	106	106
R^2	0.1819	0.1818

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

Table 1.11 Fixed-Effects Estimation (Population Limit=1,000,000 & *Pccpi*)

Dependent Variable: whether she or he makes online purchases		
Taxrate	0.2268**	0.2119**
	(0.1017)	(0.0999)
Taxdiff	-0.0676**	
	(0.0271)	
Taxratio		-7.8001**
		(3.0693)
Pccpi	0.0462**	0.0437*
	(0.0227)	(0.0234)
Lincome	0.0372***	0.0371***
	(0.0089)	(0.0089)
Female	-0.0391*	-0.0390*
	(0.0201)	(0.0201)
White	0.0648**	0.0650**
	(0.0256)	(0.0257)
Married	-0.0418	-0.0417
	(0.0279)	(0.0279)
Femared	0.0096	0.0094
	(0.0278)	(0.0279)
Whmared	-0.0037	-0.0038
	(0.0266)	(0.0266)
Fewhite	0.0117	0.0116
	(0.0257)	(0.0257)
Fewhmar	0.0388	0.0390
	(0.0349)	(0.0349)
Highgrad	0.0708***	0.0708***
	(0.0177)	(0.0177)
Colgrad	0.1031***	0.1030***
	(0.0099)	(0.0099)
Prograd	0.0208	0.0209
	(0.0148)	(0.0148)
Nch	0.0853***	0.0853***
	(0.0072)	(0.0072)
Age15	-0.1156***	-0.1157***
	(0.0222)	(0.0222)
Age20	0.0037	0.0037
	(0.0129)	(0.0129)
Age30	0.0487***	0.0487***
	(0.0127)	(0.0127)
Age50	-0.0450***	-0.0449***
	(0.0116)	(0.0116)
Age60	-0.1116***	-0.1115***
	(0.0176)	(0.0176)
D01	0.3636***	0.3648***
	(0.0263)	(0.0265)
N	13,233	13,233
# of groups	84	84
R^2	0.1934	0.1935

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

Table 1.12 Fixed-Effects Estimation (Population Limit=2,000,000 & *Pccpi*)

	Dependent Variable: whether she or he makes online purchases	
Taxrate	0.2904**	0.2903**
	(0.1165)	(0.1164)
Taxdiff	-0.0544**	
	(0.0268)	
Taxratio		-5.6301**
		(2.7799)
Pccpi	0.0602**	0.0603**
	(0.0280)	(0.0280)
Lincome	0.0303***	0.0303***
	(0.0094)	(0.0094)
Female	-0.0395*	-0.0395*
	(0.0204)	(0.0204)
White	0.0599**	0.0599**
	(0.0270)	(0.0270)
Married	-0.0573**	-0.0573**
	(0.0282)	(0.0282)
Femared	0.0144	0.0144
	(0.0306)	(0.0306)
Whmared	0.0056	0.0056
	(0.0265)	(0.0265)
Fewhite	0.0160	0.0160
	(0.0265)	(0.0265)
Fewhmar	0.0356	0.0356
	(0.0381)	(0.0381)
Highgrad	0.0716***	0.0716***
	(0.0159)	(0.0159)
Colgrad	0.1133***	0.1133***
	(0.0112)	(0.0112)
Prograd	0.0307**	0.0307**
	(0.0154)	(0.0154)
Nch	0.0878***	0.0878***
	(0.0080)	(0.0080)
Age15	-0.1164***	-0.1164***
	(0.0244)	(0.0244)
Age20	0.0006	0.0006
	(0.0156)	(0.0157)
Age30	0.0487***	0.0487***
	(0.0138)	(0.0138)
Age50	-0.0410***	-0.0410***
	(0.0127)	(0.0127)
Age60	-0.1155***	-0.1155***
	(0.0197)	(0.0197)
D01	0.3425***	0.3424***
	(0.0336)	(0.0336)
N	10,785	10,785
# of groups	67	67
R^2	0.1901	0.1901

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

Table 1.13 Fixed-Effects Estimation (Population Limit=3,000,000 & *Pccpi*)

	Dependent Variable: whether she or he makes online purchases	
Taxrate	0.3481*	0.3481*
	(0.1822)	(0.1820)
Taxdiff	-0.0110	
	(0.0436)	
Taxratio		-1.1539
		(4.5269)
Pccpi	0.0459	0.0459
	(0.0479)	(0.0479)
Lincome	0.0311***	0.0311***
	(0.0119)	(0.0119)
Female	-0.0438*	-0.0438*
	(0.0229)	(0.0229)
White	0.0292	0.0292
	(0.0276)	(0.0276)
Married	-0.0738**	-0.0738**
	(0.0310)	(0.0310)
Femared	0.0325	0.0325
	(0.0383)	(0.0383)
Whmared	0.0216	0.0216
	(0.0340)	(0.0340)
Fewhite	0.0244	0.0244
	(0.0376)	(0.0376)
Fewhmar	0.0213	0.0213
	(0.0552)	(0.0552)
Highgrad	0.0659***	0.0659***
	(0.0181)	(0.0181)
Colgrad	0.1141***	0.1141***
	(0.0138)	(0.0138)
Prograd	0.0345*	0.0345*
	(0.0209)	(0.0209)
Nch	0.0773***	0.0773***
	(0.0101)	(0.0101)
Age15	-0.1167***	-0.1167***
	(0.0332)	(0.0332)
Age20	-0.0014	-0.0014
	(0.019)	(0.019)
Age30	0.0644***	0.0644***
	(0.0175)	(0.0175)
Age50	-0.0356**	-0.0356**
	(0.0167)	(0.0167)
Age60	-0.1066***	-0.1066***
	(0.0275)	(0.0275)
D01	0.3766***	0.3766***
	(0.0597)	(0.0597)
N	5,690	5,690
# of groups	29	29
R^2	0.2017	0.2017

The numbers in parentheses are robust standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. # of groups is the number of counties represented in the sample.

1.4. Conclusion

In the previous section, I analyze empirically the effects of sales-tax rates and geographic variables on Internet shopping. If I place no restrictions on the sample, and do not use an inflation variable, the estimates for the sales-tax rate without population limits give the expected signs, but the estimates are not statistically significant. The estimates for the geographic variables do not give the expected signs.

If I focus on metropolitan areas with population above certain limits, the estimates for the sales-tax rate and the geographic variables are of the expected signs, and they are statistically significant. When I choose the metropolitan areas whose populations are above one, two, and three million, the sales-tax rate has a positive effect on online purchases. In addition, an individual would be less likely to buy goods over the Internet when she resides in a region adjoining regions with lower sales-tax rates.

Although I get the expected results in the sample of large population metropolitan areas, I do not get the expected signs of the geographic variables and the statistical significance of the sales-tax rate without population limits. My interpretation of this result is that a person who lives in a small town would not have sufficient Internet facility and an incentive to cross the border to shop goods at the retail markets of adjoining jurisdictions. Thus, she would not be likely to use Internet shopping if her own jurisdiction has a high sales-tax rate. In addition, she would not be likely to use cross-border shopping, because there might not exist adjoining jurisdictions whose sales-tax rates are lower than that of her home jurisdiction. No-population-limit data are not especially well-suited to the task of estimating the effects of sales-tax differences on cross-border shopping and sales-tax rates on Internet shopping. On the other hand, metropolitan-area data with population limits are much better suited to the task, because the life-styles and physical Internet infrastructures of metropolitan areas are suited to Internet shopping, and metropolitan areas may have convenient highway systems that are necessary to cross-border shopping.

Demographic variables have predictable signs and are statistically significant. I also observe that Internet infrastructure, such as the number of computers in the household, has an influence on online purchases. I also find that the amount of Internet shopping increases dramatically during the period studied.

According to my estimates, online commerce is more sensitive to the sales-tax rate if I increase the population limit. The tax elasticities with a population limit of three million are above 4. Thus, state or local governments with high sales-tax rates that include metropolitan areas with large populations would suffer from erosion of the tax base. Since Internet shopping is very sensitive to sales-tax rates in big metropolitan areas, it appears that state and local governments with high sales-tax rates suffer from severe tax evasion because of Internet shopping, all else equal.

On the other hand, the geographic variables such as the sales tax-rate differentials and the sales-tax ratios appear to have negative effects on Internet shopping. Even if a consumer lives in a local jurisdiction which has a high sales-tax rate, he would be less likely to use online commerce when his local county adjoins other counties with lower sales-tax rates, all else equal.

My interpretation is that a consumer crosses the border and buys goods in jurisdictions with lower sales-tax rates (i.e., the consumer engages in cross-border shopping). Thus, if a county has high sales-tax rates, it appears that the county will suffer from erosion of its tax base, although the mechanism by which this occurs will be different in different cases. If the surrounding counties have similar tax rates, then the local consumers may turn to Internet shopping. If the surrounding counties have lower tax rates, then the local consumers will not be so likely to engage in Internet shopping, but this may mean that they are merely engaging in cross-border shopping, instead.

Chapter 2: Does Sales-Tax Evasion on Remote Sales Reduce Welfare?

2.1. Introduction

Online shopping and mail-order purchases are developing very rapidly. Consumer mail-order sales are estimated to be $208,787 million in calendar year 2000 and $216,720 million in calendar year 2001. They are expected to increase to $264.7 billion by 2005[32]. E-commerce is expected to increase to $164.2 billion by 2005. The growth rate of e-commerce is substantially larger than that of mail-order sales.

Generally, it is relatively easy to escape sales taxes by engaging in remote sales.[33] Tax evasion is one reason for the relatively rapid growth of remote sales. Sales-tax evasion is a growing issue with e-commerce and mail-order purchases. Sellers have an obligation to collect sales taxes from consumers. However, state and local governments cannot require sellers to collect sales tax from consumers if sellers do not have "nexus" (physical presence) in the jurisdiction where goods are purchased[34]. The buyer is supposed to report that purchase and fill out a use-tax form. However, state and local governments do not have effective methods of enforcing the use tax, so use-tax evasion is widespread. As a result, use-tax revenues are relatively small, compared to the amount that legally should be collected.

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[32] National Mail Order Association and Michigan Department of Treasury.
[33] "Remote sales" refers to both e-commerce and mail-order purchases.
[34] The Supreme Court issued these rulings in 1992 in the case of *Quill v. North Dakota* and in 1967 in the case of *National Bella Hess v. Department of Revenue of the State of Illinois*.

The loss of sales and use-tax revenue from remote sales is probably severe, and taxation of mail-order purchases and Internet sales is a serious issue for state and local governments. However, it is difficult to obtain precise estimates of the revenue loss. It is especially difficult to measure the total revenue loss for the nation as a whole exactly, because the sales-tax rates of states governments are different, and some state governments allow their local governments to impose local sales taxes.

In spite of the difficulties of estimating the revenue losses, some attempts have been made to estimate them. Table 2.1 and Table 2.2 show Michigan use tax revenue loss from mail-order shopping and E-commerce, and the sales tax loss from not imposing the sales tax on food, drugs, and services respectively. The state of Michigan is estimated to lose $210.1 million of sales and use tax revenues from mail-order purchases and Internet shopping in fiscal year (FY) 2001.[35] Mail-order purchases explain $156.2 million of the revenue loss, and Internet shopping explains the other $53.9 million. By FY 2005, the revenue loss from remote sales is forecast to grow to $349 million, and mail-order purchases and Internet shopping are expected to account for $188.4 million and $160.3 million, respectively. Since e-commerce is increasing very rapidly, the expected revenue loss in Michigan is projected to increase.

In order to prohibit discriminatory taxes on the Internet, Congress passed the Internet Tax Freedom Act (ITFA) in 1998. The ITFA prohibits any state and local taxes on Internet access and any discriminatory taxes on the Internet. However, sales and use taxes can still be imposed on goods sold by remote sales. The ITFA does not allow consumers to avoid the sales and use tax for remote sales. On the other hand, state and local

[35] Michigan Department Treasury, Office of Revenue and Tax Analysis. Tax Revenue Loss Estimates for Consumer Remote Sales. Lansing, MI, 2001.

Table 2.1 Michigan Sales and Use Tax Revenue Loss from Consumer Remote Sales

Fiscal Year	Mail-Order Purchases	E-Commerce	Total Remote Sales
1995	$104.4	NA	$104.4
1996	$112.8	NA	$112.8
1997	$123.0	$7.2	$130.2
1998	$131.7	$14.0	$145.7
1999	$138.8	$25.1	$163.9
2000	$149.3	$37.3	$186.7
2001	$156.2	$53.9	$210.1
2002	$163.6	$76.0	$239.6
2003	$172.0	$101.5	$273.4
2004	$180.2	$128.9	$309.1
2005	$188.4	$160.3	$348.7

All amounts are million of dollars.
Source: Tax revenue Loss Estimates for Consumer Remote Sales, Lansing, MI, 2001.

Table 2.2 Michigan Sales and Use Tax Revenues, and Tax Loss Estimates

Year	2000	2001
Sales and Use Tax Revenues	$7,632,900	$7,685,900
Loss of Use Tax from Mail-Order Purchases	$149,300	$156,000
Loss of Use Tax from E-Commerce	$37,300	$54,000
Sales Tax Loss from Exempting Food	$888,000	$900,000
Sales Tax Loss from Exempting Drugs	$199,000	$269,000
Sales Tax Loss from Exempting Services	$4,260,000	$4,584,000
Per Capita Personal Income	$29,516	$29,788

All values except for per-capita personal income are thousands of dollars. Per-capita personal income is measured in dollars.
Source: Michigan Department of Treasury and the Bureau of Economic Analysis.

governments do not have reliable methods to enforce the sales and use tax from Internet shopping and mail-order purchases.

Some articles in the literature address the welfare effect and the excess burden when there is commodity-tax avoidance in the form of cross-border shopping. Lovely (1994) compares a no-tax-avoidance equilibrium with an equilibrium characterized by cross-border shopping. She finds that, under certain conditions, the consumer's welfare decreases when there is cross-border shopping among small jurisdictions, and the government faces a revenue requirement. The reason she suggests is that resources wasted by tax avoidance exceed the benefit of consumption changes by cross-border shopping. She shows that a revenue-neutral tax reform to deter cross-border shopping could increase the consumer's welfare.

Trandel (1992) uses a spatial competition model of firms to analyze the welfare effects of cross-border shopping by consumers. According to his analysis, the existence of use-tax evasion in cross-border shopping can lead firms to charge lower prices than if use-tax evasion were impossible. As a result, use-tax evasion could raise[36] economic welfare even when a higher tax rate is needed, if it reduces the seller's market power. In his model, the seller is assumed to have market power, but I do not assume that there is seller's market power.

Unlike the case of tax avoidance through cross-border shopping, however, there is not currently any literature to assess the welfare change or the excess burden associated with e-commerce and mail-order shopping.

[36] Trandel's result is contrary to the general view that tax evasion leads to welfare losses. Yitzhaki (1987) shows that tax evasion is related to uncertainty, which leads to a utility loss. In Yitzhaki's model, as a result of tax evasion, the excess burden of a distortionary tax becomes larger.

In this study, I analyze the welfare change that would occur if the sales and use tax were collected successfully from remote sales. That is, I will compare the consumer's welfare in two cases; one in which consumers can escape the sales and use tax by engaging in remote sales, and the other in which state and local governments can impose the sales and use tax on remote sales successfully, and use the resulting revenue to decrease sales-tax rates. The first case describes the present reality. The second case describes an ideal world, in which state and local governments can collect the sales and use tax from e-commerce and mail-order shopping. The welfare of the tax-evaded economy will be compared with that of the economy with no tax evasion in this study.

In order to do so, I will derive a benchmark case, an economy with lump-sum taxation. The excess burden of each sales-tax system is a deadweight loss that would occur if the tax system were not lump-sum taxation. If we compare their excess burdens, we can conclude which one is preferable to consumers. I will also compare the tax-evasion economy with the no-tax-evasion economy directly. I will also calculate the excess burden of the current sales-tax system. If we assume that the current sales-tax system is changed marginally in the direction of the new sales-tax system, we could calculate the excess burden of one dollar of revenue in the current sales-tax system.

In section 2.2, I will show a basic framework for this study, and I will summarize data in section 2.3. In section 2.4, I will analyze the welfare effect of the new revenue-neutral tax policy using the Cobb-Douglas and CES utility function. The last section will summarize the results.

2.2. Theoretical Background

I use partial-equilibrium analysis to weigh the welfare effect of imposing the sales tax successfully on remote sales. I use differential-incidence analysis[37] instead of balanced-budget incidence analysis. This means that I hold the total sales and use-tax revenues fixed. When the state government collects the sales tax from remote sales, the total sales-tax revenues are assumed to be equal to those that were collected when consumers could evade the sales tax from remote sales. In order to hold tax revenues constant, it is necessary to adjust the tax rate when the tax base is broadened. Since the comparison is between the current sales-tax system and a new equal-revenue tax system, the income effect washes out.

I model the economy in terms of a representative consumer. Therefore, there is no distributional issue in this economy. I consider the case in which the representative consumer has a Cobb-Douglas (C-D) utility function as well as the more general case of a CES utility function. The representative consumer is assumed to consume three kinds of goods: taxed goods, untaxed food and services,[38] and untaxed remote sales goods. The model does not include foreign trade or international capital flows. In this model, there are no externalities, and the only distortion is the sales and use tax. This model does not divide government expenditure into parts such as exhaustive projects and transfer payment programs.[39] It is assumed that government sales-tax revenues are fixed, and that

[37] Rosen, Harvey S., Public Finance, 5th edition. Irwin/McGraw-Hill.
[38] Many state governments do not impose their sales taxes on food and services, and the forgone revenues from those items are huge. In the U.S. as a whole, services represented 45.4% of GDP in 1980, and 65.9% in 2000 (Slemrod, 2002).
[39] I do not cover the calculations of marginal cost of public funds (MCF) and marginal efficiency cost of redistribution (MECR) in this study (see Ballard (1988) for a discussion of the MECR, and Ballard (1991)

the composition of the sales-tax revenues would be changed after the new-tax policy: the revenue requirement is exogenous. I use the real sales and use tax revenues of the state of Michigan.[40]

The representative consumer purchases goods to maximize his utility function, subject to his budget constraint. His problem is,

$$\underset{x_1, x_2, x_3}{Max} \; U = f(x_1, x_2, x_3)$$

$$s.t. \; W = \sum_{i=1}^{3} q_i x_i \tag{2.1}$$

where x_1 represents taxed retail goods, x_2 represents untaxed food and services, and x_3 represents untaxed remote sales. W is the representative consumer's income, and q_i is the consumer price for each good. q_i consists of the producer price and the sales-tax rate (p_i+t). In this model, it is assumed that the producer price (p_i) is fixed, and the sales-tax rate (t) is changeable. Therefore, any change of the consumer price must result from a change in the sale-tax rate. Suppose that the utility function, U, is twice differentiable and strictly quasi-concave. The Lagrange function for this problem is,

$$L = f(x_1, x_2, x_3) + \lambda(W - \sum_{i=1}^{3} q_i x_i) \tag{2.2}$$

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for a discussion of the MCF), because this study is not concerned with changes in government expenditure programs.

[40] http://www.michigan.gov/treasury.

Differentiating the Lagrange function with respect to x_1, x_2, and x_3, I get the first-order conditions for this problem.

$$
\begin{aligned}
&f_1(x_1, x_2, x_3) - \lambda q_1 = 0 \\
&f_2(x_1, x_2, x_3) - \lambda q_2 = 0 \\
&f_3(x_1, x_2, x_3) - \lambda q_3 = 0 \\
&W - \sum_{i=1}^{3} q_i x_i = 0
\end{aligned}
\tag{2.3}
$$

where f_i is the partial derivative of the utility function with respect to x_i. If I manipulate the first-order conditions and budget constraint, I can derive the ordinary demand function for each good. When I put the demand function for each good into the consumer's utility function, I get the indirect utility function, $V(q, W)$, which depends on prices and income as well as on the parameters of the utility function.

The theoretical section of the earlier chapter had Kuhn-Tucker conditions, because the analysis was at the level of individual, and the individual may experience corner solutions. Here, we assume interior solutions throughout, because the analysis is being conducted at the level of an aggregated, representative consumer.

In order to compare the tax-evasion economy (the current sales-tax system) with the no-tax-evasion economy (new equal-revenue sales-tax system), I derive the Excess Burden that would be calculated if the lump-tax economy with equal revenue were replaced with each tax system. The excess burden from the current sales-tax system will be compared with one from the alternative sales-tax system. It can tell us which sales-tax system is more desirable for consumers.

2.2.1. Specification of the Model in the Case of Sales-Tax Evasion and Avoidance.

Because of tax evasion, the consumer price of remote sales, q_3, should be equal to the producer price, p_3. In general, a consumer price is composed of the producer price and the sales tax, that is, $q_i=(1+t)p_i$. However, the consumer price of remote sales is equal to the producer price, p_3, because the representative consumer escapes the sales-tax burden.

In addition, the consumer price for food and services[41] is also equal to the producer price, because state and local governments do not collect sales and use tax from them: $q_2=p_2$. However, the consumer price of general retail goods is different from their producer price. In other words, the consumer price of general retail goods, q_1, consists of their producer price times ($1+$ *sales-tax rate*), that is, $q_1=p_1(1+t)$. I use the existing sales-tax rate, t, to calculate the consumer price in this setup. Some states have a constant sales-tax rate across the state, but other states have different sales-tax rates in different parts of the state, because counties and municipalities can impose their own sales taxes. I use data for Michigan in my simulations. The state of Michigan has a 6% constant sales-tax rate across the state.

Let the superscript, e, refer to the sales-tax evasion economy (the current sales-tax economy). Thus, q^e and t^e are the consumer price and sales-tax rate vector with the sales-tax evasion economy, and p is the producer price vector. According to Kay (1980),

[41] Generally, the sales and use tax is not imposed on services. However, state and local governments impose the sales tax on some service activities such as telephone, vehicle lease payments, and hotel and motel charges. Several states impose sales tax on food, but Michigan (like most other states) does not. Some states that tax food have an income-tax credit for estimated sales-tax payments on food, in an attempt to offset regressivity.

Pazner and Sadka (1980), and Triest (1990), the excess burden in the sales-tax evasion economy is,

$$EB(q^e, p, W) = W - E(p, V(q^e, W)) - T(q^e, p, W) \tag{2.4}$$

$EB(q^e,p,W)$ is the excess burden from the current sales-tax system which is characterized by the tax evasion, $E(p,V(q^e,W))$ is the expenditure function to achieve the utility level, $V(q^e, W)$, under the lump-sum tax economy, and $T(q^e,p,W)$ is the sales-tax revenue under the current sales-tax system, $T(q^e,p,W)=t^e \times x_1(q^e,W)$. $EB(q^e,p,W)$ is the additional burden that the representative consumer would bear if the distortionary current sales-tax economy were substituted for lump-sum taxation, while keeping the consumer welfare at his post-tax level, $v(q^e,W)$(See Pazner and Sadka, 1980).

2.2.2. Specification of the Model for Uniform Sales-Tax Rate, with no Evasion or Avoidance.

The consumer price for remote sales is different from the producer price when governments can impose sales tax successfully on e-commerce and mail-order purchases. Its consumer price, q_3, is composed of the producer price and the sales-tax rate, $p_3(1+t)$. The consumer price for general retail goods, q_1, is also composed of the producer price and the sales-tax rate, $p_1(1+t)$. However, I assume that state and local governments do not change their policy toward food and services. In other words, state and local governments do not impose the sales and use tax on food and services in this setup. Thus, the consumer price for food and services, q_2, is the same as the producer price, p_2.

In this section, sales and use tax is collected from remote sales, as well as from sales of goods that were previously taxed. The new sales-tax rate, which can make the sales-tax revenues equal to the sales-tax revenues of the previous section, is smaller than the existing sales-tax rate. The reason is that the tax base is broadened in this section.

Let superscript n represent the new economy with no tax evasion. q^n and t^n are the new consumer price and tax rate vector corresponding to the new sales-tax system (in the no tax-evasion economy). The excess burden of the new equal-revenue economy is,

$$EB(q^n, p, W) = W - E(p, V(q^n, W)) - T(q^n, p, W) \tag{2.5}$$

$EB\ (q^n,\ p,\ W)$ is the additional burden that the representative consumer should bear if lump-sum taxation were replaced with the new sales-tax system, while keeping the consumer welfare at his post-tax level, $v(q^n, W)$(Pazner and Sadka, 1980). $E(p, V(q^n, W))$ is the expenditure function to achieve the utility level, $V(q^n, W)$, under the lump-sum tax economy, and $T(q^n, p, W)$ is the sales-tax revenue under the new sales-tax system, $T(q^n, p\ W) = t^n \times x_1(q^n, W) + t^n \times x_3(q^n, W)$.

2.2.3. Comparison of the current sales-tax system with the new sales-tax economy

I can compare the current sales-tax system (with sales-tax evasion on remote sales) with the new sales-tax economy (with no tax evasion), for the purpose of calculating the excess burden. According to Pazner and Sadka (1980), the comparisons of the excess burdens can give rise to the correct utility ranking of alternative tax schemes, which yield the same amount of tax revenue. When $EB(q^e,p,W)$ is larger than $EB(q^n,p,W)$, we can say that the new sales-tax system is superior to the current tax-evasion economy, and vice versa. The former case explains the inefficiency of tax evasion on e-commerce and mail-order shopping, and shows policy implications regarding the imposition of sales tax on remote sales.

I also investigate the excess burden of the current sales-tax system using the equivalent variation (EV) and compensating variation (CV)[42] if we assume that the current sales-tax system is replaced with the new equal-revenue tax economy. Excess burden is derived, to calculate the inefficiency of the current sales-tax system. It is the differential welfare change per dollar of revenue (Ballard, 1990, and Ballard and Fullerton, 1992).[43]

[42] In calculating the change in consumer's welfare, Ballard, Shoven, and Whalley (1985) use the equivalent variation (EV). EV and CV are equivalent at the margin (See Mayshar, 1990). Therefore, I will use EV and CV. Note that Stuart (1984) uses the compensating surplus (CS). See Fullerton (1991) and Stuart (1984).

[43] Originally, this is used to compare a particular type of distortionary tax system with an equal-revenue lump-sum tax. This should be used in differential incidence analysis. In this paper, I use it to calculate the excess burden of the current sales-tax system.

Excess Burden=$\Delta W/\Delta T$

ΔW: Change in Consumer Welfare

ΔT: Amount of Tax Revenue replaced with the equal-revenue tax system (2.6)

For the numerator, I use the equivalent variation (EV) or compensating variation (CV) when the current sales-tax system is replaced with the new equal-revenue sales-tax system. When I calculate the denominator, the amount of tax revenue from remote sales after the tax-policy change will be used.

$$\begin{aligned} EV(q^e, V^n) &= W - E(q^e, V(q^n, W)) \\ CV(q^n, V^e) &= E(q^n, V(q^e, W)) - W \end{aligned} \tag{2.7}$$

$$\Delta T = t^n * x_3(q^n, W) \tag{2.8}$$

The excess burden measures the additional welfare costs per dollar of tax revenue of the current sales-tax system in Michigan due to the sales-tax evasion. Therefore, the excess burden could be decreased if the state of Michigan selected the new tax policy.

2.3. Data

I use data for the state of Michigan in fiscal year (FY) 2000 and 2001.[44] I get the important values from the Department of Treasury in Michigan and its tax reports.[45] For example, these include the general sales and use tax revenues for the state of Michigan in FY 2000 and 2001. I also get the estimates of the loss of use-tax revenues from remote sales in FY 2000 and 2001. In addition, the state of Michigan does not impose the sales and use tax on food, drugs, and services, so I obtain estimates of these revenue losses from the Department of Treasury of Michigan and its tax reports.

Table 2.3 Estimates of the Sales Amount of Each Good (thousands of dollars)

Year	2000	2001
General Retail Goods	$127,215,000	$128,098,333
Mail-Order Purchases	$2,488,333	$2,600,000
E-Commerce	$621,667	$900,000
Food	$14,800,000	$15,000,000
Drugs	$3,316,667	$4,483,333
Services	$71,000,000	$76,400,000

These amounts are net of the sales tax.
Source: Michigan Department of Treasury and the Bureau of Economic Analysis.

[44] The fiscal year of the state of Michigan runs from October 1 to September 30.
[45] Michigan Department of Treasury, Office of Revenue and Tax Analysis. Michigan Sales and Use Tax. Lansing, MI, 2001 and Tax Revenue Loss Estimates for Consumer Remote Sales. Lansing, MI, 2001.

I get per-capita personal income for Michigan in 2000 and 2001[46] from the Bureau of Economic Analysis. The per-capita personal incomes of Michigan in 2000 and 2001 are $29,516 and $29,788 respectively. The sales and use tax rate in Michigan has been 6% since May 1, 1994.[47] The data are summarized in Table 2.2 and Table 2.3.

The sales-tax revenue of Michigan in FY 2001 is $6,352.3 million, an increase of $74.8 million (1.2%) from FY 2000. The use-tax revenue is $1,333.6 million in FY 2001, a decrease of $21.8 million (-1.6%) from FY 2000.[48] The total loss of use-tax revenue due to tax evasion from remote sales is estimated to be $210 million and $187 million in FY 2001 and 2000, respectively. The total revenue losses from the sales-tax exemption for food, drugs, and services are estimated to be $5,753 million and $5,347 million in FY 2001 and 2000 respectively.

I can estimate the sales amount of each good using the above information and the sales-tax rate, 6%. Table 2.3 shows the sales amount of each good. According to Table 2.3, e-commerce is a very small part of consumer expenditure, but it is increasing rapidly. The growth rate of e-commerce is 50% during that period, and that of mail-order purchases is 4.7%.

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[46] http://www.bea.doc.gov/bea/regional/spi/

[47] Previously, the sales and use tax rate in Michigan was 4%.

[48] The use tax is generally paid by business sectors. The telecommunication sector and the automotive sector are the main sources for the use tax in Michigan. Most payments in the telecommunication sector are collected from interstate and intrastate telephone calls, and leasing and private sales of motor vehicles are the main sources in the automotive sector (Michigan Department of Treasury, 2001). Business services, hotels and motels, and transportation manufacturing are the other sources for use-tax revenue in Michigan.

2.4. Computation of Welfare Change

2.4.1. Cobb-Douglas Utility Function

I use a Cobb-Douglas (C-D) utility function in this section, to find a welfare change. The Cobb-Douglas utility function is quite restrictive, since it implies unitary own-price elasticities for all goods and unitary elasticities of substitution among goods. However, it is a useful starting point for the analysis. The consumer's utility function and budget constraint are,

$$\underset{x_1, x_2, x_3}{Max}\ U = x_1^{\alpha_1} x_2^{\alpha_2} x_3^{1-\alpha_1-\alpha_2}$$

$$s.t.\ W = \sum_{i=1}^{3} q_i x_i \tag{2.9}$$

x_1 represents taxed retail goods, x_2 represents untaxed food, drugs, and services, and x_3 represents untaxed remote sale goods. If we solve the representative consumer's problem to maximize the Lagrange function, we get the demand function for each good.

$$x_1 = \frac{\alpha_1 W}{q_1},\ x_2 = \frac{\alpha_2 W}{q_2},\ x_3 = \frac{(1-\alpha_1-\alpha_2)W}{q_3} \tag{2.10}$$

In order to derive the indirect utility function, I insert the demand functions (equation (2.10)) into the ordinary utility function (equation (2.9)).

$$V = (\frac{\alpha_1 W}{q_1})^{\alpha_1} (\frac{\alpha_2 W}{q_2})^{\alpha_2} (\frac{(1-\alpha_1-\alpha_2)W}{q_3})^{1-\alpha_1-\alpha_2}$$
$$= (\frac{\alpha_1}{q_1})^{\alpha_1} (\frac{\alpha_2}{q_2})^{\alpha_2} (\frac{(1-\alpha_1-\alpha_2)}{q_3})^{1-\alpha_1-\alpha_2} W \quad (2.11)$$

2.4.1.1. Computation of the excess burden when tax evasion for remote sales is widespread

Originally, the consumer price is only different from the producer price for general retail sales. All other goods, including remote sale goods, have identical consumer and producer prices. That is, (2.11) is written as

$$V(q^e, W) = (\frac{\alpha_1}{p_1(1+t)})^{\alpha_1} (\frac{\alpha_2}{p_2})^{\alpha_2} (\frac{(1-\alpha_1-\alpha_2)}{p_3})^{1-\alpha_1-\alpha_2} W \quad (2.11)'$$

In order to calculate the indirect utility, I begin by inserting per-capita personal income into W in equation (2.11)', and I assume that all producer prices are unitary. The sales-tax rate in the state of Michigan is 6%, so I use 0.06 for t in equation (2.11)'. In order to find values for α_1 and α_2, I use the fact that each α is an expenditure share when we employ the C-D utility function. Table 2.4 shows the α values in FY 2000 and 2001.

The excess burden of the current sales-tax economy due to tax evasion in remote sales, $EB(q^e, p, W) = W - E(p, V(q^e, W)) - T(q^e, p, W)$, is \$11.72 and \$11.97 per

Table 2.4 The values of αs in C-D Utility Function

Year	2000	2001
α_1	.5938	.5774
α_2	.3924	.4077
$1-\alpha_1-\alpha_2$	.0137	.0149

capita in 2000 and 2001 respectively. Thus, the analysis with the Cobb-Douglas utility function suggests that the amount by which the excess burden could decrease if the current sales-tax system were replaced with the lump-sum taxation is about $12 per person. In other words, the excess burden which a consumer bears under the current sales-tax system is almost $12.

2.4.1.2. Computation of welfare when state government can impose sales tax on remote sales

Suppose that the state government of Michigan extends the sales tax to remote sales, but that the state government still does not impose the sales tax on food and services. This broadening of the tax base would allow the state to collect the same total revenue, with a lower tax rate.

The consumer price of e-commerce and mail-order purchases changes from the unit price, 1, to (1+ *new sales-tax rate*). The consumer price of general retail goods also changes, because the state government imposes the new sales-tax rate on them. However, in this experiment, food, drugs, and services are still not the subject of the sales tax, even when there is a tax-rate change.

In order to calculate the new equal-revenue sales-tax rate, it is necessary to consider the changes in demands that will occur when consumer prices change.[49] When the representative consumer faces the new consumer prices, he changes his quantity demanded based upon the new consumer prices. In calculating the new equal-revenue sales-tax rate, I have to use this property of each demand function.

I introduce the new definitions, "*Actual Revenue*" and "*Required Revenue*" in calculating the new equal-revenue sales-tax rate.

$$\begin{aligned} &Actual\ Revenue = t^n x_1^* + t^n x_3^* \\ &Required\ Revenue = Nominal\ Base\ Tax\ Revenue\left(\frac{\bar{q}_{new}}{\bar{q}_{old}}\right) \end{aligned} \qquad (2.12)$$

t^n is the new sales-tax rate under no tax evasion, and x_1^* and x_3^* are the demands based upon the constrained maximization. Nominal Base Tax Revenue is the original sales-tax revenue, collected from the representative consumer under the current sales-tax system. $\bar{q}_{new}$ is the new composite price index, based on the new sales tax rate, and $\bar{q}_{old}$ is the original composite price index, based on the current sales-tax rate.[50]

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[49] Slemrod (2002) uses a simple method to calculate the new sales-tax rate, t, that solves the equation, t*(current sales tax revenues+use tax losses from remote sales)=0.06*current sales tax revenues. However, this does not consider the demand changes that would be caused by the new sales-tax rates.

[50] This composite price index is derived from the property of the Cobb-Douglas utility function (Ballard *et al.*, 1985).

$$\bar{q}_{new} = (\frac{1+t^n}{\alpha_1})^{\alpha_1}(\frac{1}{\alpha_2})^{\alpha_2}(\frac{1+t^n}{1-\alpha_1-\alpha_2})^{1-\alpha_1-\alpha_2}$$
$$\bar{q}_{old} = (\frac{1.06}{\alpha_1})^{\alpha_1}(\frac{1}{\alpha_2})^{\alpha_2}(\frac{1}{1-\alpha_1-\alpha_2})^{1-\alpha_1-\alpha_2} \quad (2.13)$$

I find the new equal-revenue sales-tax rate that makes *Actual Revenue* equal to *Required Revenue*. In order to do so, I guess the first new sales-tax rate, insert it into equations (2.12) and (2.13), and compare Actual Revenue with Required Revenue. If they are not equal, I change the sales tax rate. I continue with this iterative procedure until I get the sales-tax rate that makes Actual Revenue equal to Required Revenue. According to this method, the equal-revenue sales-tax rates are 5.8559% in FY 2000 and 5.8403% in 2001.

The excess burden, $EB(q^n, p, W) = W - E(p, V(q^n, W)) - T(q^n, p, W)$, if lump-sum taxation were replaced with the new sales-tax system, would be \$11.05 and \$11.25 in 2000 and 2001 respectively. In other words, the excess burden could decrease, if the new equal-revenue sales-tax system were replaced with lump-sum taxation, by about \$11.

2.4.1.3. Computation of the welfare change in C-D utility function

In order to compare the tax-evasion economy with the no tax-evasion case, their excess burdens are an important yardstick used to evaluate the deviation from the optimal economy. As I show in the previous sections, the excess burden of the current sales-tax system is bigger than that of the new sale-tax system. In particular, the per-capita excess burden of the tax-evasion economy is bigger by about 70 cents than that of the no-tax-evasion economy. This means that the tax-evasion economy is less efficient than the no-tax-evasion economy, and that the no-tax-evasion economy is superior to the tax-evasion economy.

I attain the conclusion that the new sales-tax system is better than the current sales-tax system according to the efficiency measure. I investigate how inefficient the current sales-tax system is using the excess burden, equation (2.6). To measure the excess burden, let us assume that the current sales-tax system is replaced with the new sales-tax system. I am able to get the exact values of $EV(q^e, V^n)$, $CV(q^n, V^e)$, and ΔT corresponding to the tax-policy change, and calculate its marginal excess burden.

Table 2.5 shows the result of the welfare analysis in the C-D utility function. $EV(q^e, V^n)$ and $CV(q^n, V^e)$ per capita in FY 2000 are almost \$0.7123, which is very small. $EV(q^e, V^n)$ and $CV(q^n, V^e)$ per capita in FY 2001 are about \$0.7742, and this is also very small. Even if I interpret EV and CV as a percentage change of income, they are very small numbers. EV and CV in FY 2000 are approximately 0.0024% of the representative income, and they are almost 0.0026% of his income in FY 2001. The excess burden per dollar is roughly .0317 in 2000 and .0316 in 2001.

Thus, the excess burden which is derived from the sales-tax evasion is about 3 cents per dollar of revenue. Therefore, the representative consumer would prefer the new equal-revenue sales-tax system to the current sales-tax system. These results are consistent with the traditional optimal taxation theory, that the uniform taxation[51] is optimal under some conditions.[52]

[51] In the current setting, in which it is assumed that the sales tax is the only distortion, second-best considerations are minimal. Consequently, it is not surprising that this movement toward the optimal tax system is associated with a welfare improvement.
[52] The utility function should be homothetic, and the utilities of consumption goods should be separable from leisure. In other words, labor, negative leisure, should be inelastically supplied with respect to all consumer goods prices. In this model, I do not cover leisure and labor explicitly, so the model satisfies the conditions for optimality of uniform taxes.

State and local governments could lower the sales-tax rate by broadening the sales-tax base, to deter sales-tax evasion. By doing so, state and local governments could increase the welfare of their residents. In this model, I estimate the equal-revenue sales-tax rate to be about 5.8%, which is a little bit lower than the existing sales-tax rate, 6%. Since e-commerce is increasing rapidly and mail-order purchasing is also increasing very stably, the equal-revenue sales-tax rate might be much lower than the existing sales-tax rate in future years. Thus, the excess burden from sales and use tax evasion could grow over the time.

Table 2.5 Computation of Welfare Change in C-D Utility Function

Year	2000	2001
EV	.71228	.77421
EV/W	.00002	.00003
EV/ΔT	0.03168345	0.031647993
CV	.71226	.77419
CV/W	.00002	.00003
CV/ΔT	0.031682686	0.031647171

EV is the equivalent variation and *CV* is the compensating variation. *W* is per-capita personal income in Michigan. ΔT is the amount of sales-tax revenues from the new tax base (remote sales) after the policy change. *EV/ΔT* and *CV/ΔT* are the excess burden per dollar of revenue.

2.4.2. CES Utility Function

Next, I use the constant elasticity of substitution (CES) utility function to calculate the welfare change due to the policy change. I include general retail goods and remote sale goods (mail-order purchased goods and online purchased goods) in the CES utility function. I remove food and services in this setup, because I would need the elasticity of substitution between e-commerce goods, and food and services, to specify a CES utility function that includes all three categories of goods. However, there is no empirical work that finds their elasticity of substitution. Therefore, I consider only taxed general retail goods and remote-sale goods in this section.

The representative consumer's problem is,[53]

$$Max.\ U = (\beta^{\frac{1}{\sigma}} x_1^{\frac{\sigma-1}{\sigma}} + (1-\beta)^{\frac{1}{\sigma}} x_2^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$$

$$s.t.\ W = q_1 x_1 + q_2 x_2 \tag{2.14}$$

where x_1 is taxed general retail goods and x_2 is remote-sale goods. q_1 and q_2 are the consumer prices of x_1 and x_2, and W is the income of the representative consumer. σ is the elasticity of substitution between x_1 and x_2, and β is a weighting parameter. Constrained maximization leads to the first-order conditions,

[53] I follow Ballard (1988 and 1990) in his CES utility function.

$$(\frac{\sigma}{\sigma-1})(\beta^{\frac{1}{\sigma}} x_1^{\frac{\sigma-1}{\sigma}} + (1-\beta)^{\frac{1}{\sigma}} x_2^{\frac{\sigma-1}{\sigma}})^{\frac{1}{\sigma-1}} (\frac{\sigma-1}{\sigma}) \beta^{\frac{1}{\sigma}} x_1^{-\frac{1}{\sigma}} - \lambda q_1 = 0$$

$$(\frac{\sigma}{\sigma-1})(\beta^{\frac{1}{\sigma}} x_1^{\frac{\sigma-1}{\sigma}} + (1-\beta)^{\frac{1}{\sigma}} x_2^{\frac{\sigma-1}{\sigma}})^{\frac{1}{\sigma-1}} (\frac{\sigma-1}{\sigma})(1-\beta)^{\frac{1}{\sigma}} x_2^{-\frac{1}{\sigma}} - \lambda q_2 = 0 \quad (2.15)$$

$$W - q_1 x_1 - q_2 x_2 = 0$$

where λ is Lagrange multiplier in the constrained maximization. If I manipulate the first two equations of (2.14), I get the relationship between x_1 and x_2,

$$\frac{x_2}{x_1} = (\frac{q_1}{q_2})^{\sigma} \frac{(1-\beta)}{\beta} \quad (2.16)$$

If I manipulate equation (2.14), I obtain the demand functions for x_1 and x_2,

$$x_1 = \frac{W}{q_1 + q_2(\frac{1-\beta}{\beta})(\frac{q_1}{q_2})^{\sigma}}$$

$$(2.17)$$

$$x_2 = \frac{W}{q_2 + q_1(\frac{\beta}{1-\beta})(\frac{q_2}{q_1})^{\sigma}}$$

In order to calculate the real values of the indirect utility function and expenditure function, I have to specify the elasticity of substitution, σ, and the weighting parameter, β. The technique of calibration is employed here, to obtain the values of the elasticity of substitution and the weighting parameter. Differentiating the demand function for x_2 with respect to q_1, yields,

$$\frac{\partial x_2}{\partial q_1} = \frac{x_2(\sigma-1)(\frac{\beta}{1-\beta})(\frac{q_2}{q_1})^{\sigma}}{q_1(\frac{\beta}{1-\beta})(\frac{q_2}{q_1})^{\sigma}+q_2} \tag{2.18}$$

Using equations (2.18) and (2.16) leads to,

$$\frac{\partial x_2}{\partial q_1} = \frac{x_2(\sigma-1)(\frac{x_1}{x_2})}{q_1(\frac{x_1}{x_2})+q_2} \tag{2.18'}$$

In this model, a consumer price, q_i, consists of a producer price, p_i, and the sales-tax rate, t $(q_i=p_i^{*}(1+t))$. I assume that each producer price is unity, and that only a change in the sales-tax rate can lead to a change in a consumer price. Thus, the change in consumer price is equal to the change in the sales-tax rate ($dq_i=dt$). If I use this relationship between a consumer price and the sales-tax rate, I get the tax elasticity of remote sale goods, ε,

$$\varepsilon = \frac{\partial x_2}{\partial t}\frac{(1+t)}{x_2} = \frac{\partial x_2}{\partial q_1}\frac{q_1}{x_2}\frac{(1+t)}{q_1} = \frac{(1+t)(\sigma-1)(\frac{x_1}{x_2})}{q_1(\frac{x_1}{x_2})+q_2} \tag{2.19}$$ [54]

[54] Goolsbee (2000) selects *(1+sales tax rate)* as an explanatory variable in his model. Thus, his tax elasticity is

Goolsbee (2000) obtains tax elasticities of online purchased goods that are 2.3, 3.4, and 4.3.[55] However, the tax elasticity in his study is calculated from the binary variable, namely, whether the consumer would be likely to make online purchases when the sales-tax rate increases by .01. This is not how much she or he increases online purchases when a sales-tax rate increases by .01, which is the original idea of the tax elasticity.

In order to calibrate some parameters and calculate the excess burden correctly, it is most appropriate to use the compensated elasticity that corresponds to the original tax elasticity, because this study uses the differential incidence approach. However, I cannot obtain the data about the amount of online goods purchased by the consumer, and there is no empirical work that finds the original tax elasticity. Therefore, I use the tax elasticities of Goolsbee's work in this model.

When I manipulate equation (2.19), I get equation (2.19)' and then insert real values into equation (2.19)'. After the calibration, the elasticities of substitution between general retail goods and remote sales goods, σ, are about 3.4, 4.5, and 5.4.[56] These elasticities of substitution are larger than that of the C-D utility function (=1). When sales-tax rates change, a consumer with this CES utility function would make much larger changes to

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$\frac{\partial x_2}{\partial(1+t)}\frac{(1+t)}{x_2}$, and the change in *(1+t)* is equal to the change in *t* itself. His tax elasticity is equal to equation (2.19).

[55] Goolsbee (2000) uses three groups of his sample in his analysis. To begin with, he uses all individuals and gets the tax elasticity, 2.3. Second, he selects the residents who live in states with constant sales-tax rates. With this sample, the calculated tax elasticity is 4.3. The last group that he analyzes is the individuals who live in metropolitan areas. He finds that the tax elasticity is 3.4 when this sample is used.

[56] The exact values of the elasticities of substitution and weighting parameters are shown in Table 2.6, Table 2.7, and Table 2.8.

his consumption combination between general retail goods and remote sales goods than if the consumer's behavior were governed by a C-D utility function.

$$\sigma = 1 + \frac{\varepsilon[q_1(\frac{x_1}{x_2}) + 1]}{(1+t)(\frac{x_1}{x_2})} \qquad (2.19)'$$

I calculate the value for the weighting parameter, β, using equation (2.16) and the elasticities of substitution which are derived before. The weighting parameters, β, are about .98 in each case.

In order to calculate the welfare change, I have to use these values to derive the excess burden of the current sales-tax system. The indirect utility function is derived if I use each demand function for x_1 and x_2 and the utility function. The indirect utility function is,

$$V(q,u) = W\{\beta^{\frac{1}{\sigma}}[q_1 + q_2(\frac{1-\beta}{\beta})(\frac{q_1}{q_2})^{\sigma}]^{\frac{1-\sigma}{\sigma}} + (1-\beta)^{\frac{1}{\sigma}}[q_2 + q_1(\frac{\beta}{1-\beta})(\frac{q_2}{q_1})^{\sigma}]^{\frac{1-\sigma}{\sigma}}\}^{\frac{\sigma}{\sigma-1}} \qquad (2.20)$$

2.4.2.1. Computation of the excess burden when tax evasion for remote sales is widespread

Legally, the residents in state of Michigan have to pay the use tax when they purchase goods over online or by mail-order. However, a consumer can evade paying the use tax very easily in remote sales, so the consumer price of remote sale goods is the same as its producer price. The consumer price of general retail goods is different from its producer price.

In order to calculate the excess burden of a representative consumer, $EB(q^e,p,W)$, I use 1.06 and 1 for q_1 and q_2, and per-capita personal income in Michigan for W. For β and σ, I use the values which I obtain in the calibration process. The per-capita excess burden of the current economy (with sales-tax evasion), when compared with the case of lump-sum taxation, is \$3.42, \$4.48, and \$5.31 in 2000, and \$3.84, \$5.02, and \$5.96 in 2001, with the different values corresponding to the different values of the tax elasticity.

2.4.2.2 Computation of the excess burden when state government can impose sales tax on remote sales

Suppose that the state government of Michigan can collect the sales and use tax successfully from remote sales, and use the revenues to decrease its sales-tax rate. As in the case of the C-D utility function, this analysis is a differential-incidence analysis. Therefore, the total sales-tax revenues are constant, even when government policies change.

In order to obtain the equal-revenue sales-tax rate, I compare the *Required Revenue* with the *Actual Revenue*, and find the sales-tax rate that makes them equal. This sales-tax rate will guarantee equal sales-tax revenues after the policy change. Equation (2.12) gives the idea for the *Required Revenue* and *Actual Revenue*. However, I have to use different composite price indices in the *Required Revenue* from those in the C-D utility function. The old and new composite price indices in the CES utility function are[57]

$$\bar{q}_{old} = (\beta q_{1old}^{1-\sigma} + (1-\beta) q_{2old}^{1-\sigma})^{\frac{1}{1-\sigma}}$$
$$\bar{q}_{new} = (\beta q_{1new}^{1-\sigma} + (1-\mathrm{B}) q_{2new}^{1-\sigma})^{\frac{1}{1-\sigma}} \quad (2.21)$$

where q_{1old} and q_{2old} are 1.06 and 1 respectively, and q_{1new} and q_{2new} are the new consumer prices for x_1 and x_2. When I follow the same iteration procedure as in the C-D utility function, I obtain the equal-revenue sales-tax rate in the CES utility function too. The new sales-tax rates that make the sales-tax revenues constant are shown in Table 2.6, Table 2.7, and Table 2.8. They are in the range of 5.84% through 5.86%.

When I use the new consumer prices, I am able to obtain the excess burden of the new sales-tax system (with no tax evasion), $EB(q^n,p,W)$, which is caused by non-lump-sum taxation. The excess burdens of the new sales-tax system are zero in all cases. The new sales-tax system is uniform taxation and is optimal from the point of view of efficiency. In my model, there is no labor-leisure choice, and the CES utility function is homothetic. Therefore, uniform taxation is optimal. My analysis to measure the excess burden of the new sales-tax system demonstrates the traditional optimal taxation theory numerically.

[57] The composite price index is based upon the CES utility function (Ballard, 1990).

Table 2.6 Computation of Welfare Change Using the CES Utility Function (Tax Elasticity=2.3)

	2000	2001
Elasticity of Substitution (σ)	3.353158658	3.359285234
Weighing Parameter (β)	0.980247004	0.978028166
New Sales Tax Rate (t)	.05855712220587	0.0583952853071
EV	3.845931996	4.313453974
EV/W	0.000130300	0.000144805
$EV/\Delta T$	0.119246515	0.119450405
CV	3.845430937	4.312829454
CV/W	0.000130283	0.000144784
$CV/\Delta T$	0.119230980	0.119433110

EV is the Equivalent Variation and *CV* is the Compensating Variation. *W* is per-capita personal income in Michigan. ΔT is an amount of sales-tax revenues from the new tax base (remote sales) after the policy change. $EV/\Delta T$ and $CV/\Delta T$ are the excess burden.

Table 2.7 Computation of Welfare Change Using the CES Utility Function (Tax Elasticity=3.4)

	2000	2001
Elasticity of Substitution (σ)	4.478582363	4.487639041
Weighing Parameter (β)	0.981477568	0.979397498
New Sales Tax Rate (t)	0.05855462817169	0.05839251893086
EV	5.033726425	5.647012309
EV/W	0.000170542	0.000189573
$EV/\Delta T$	0.166450899	0.166781154
CV	5.032868108	5.645941989
CV/W	0.000170513	0.000189537
$CV/\Delta T$	0.166422517	0.166749543

EV is the Equivalent Variation and *CV* is the Compensating Variation. *W* is per-capita personal income in Michigan. ΔT is an amount of sales-tax revenues from the new tax base (remote sales) after the policy change. $EV/\Delta T$ and $CV/\Delta T$ are the excess burden.

Table 2.8 Computation of Welfare Change Using the CES Utility Function (Tax Elasticity=4.3)

	2000	2001
Elasticity of Substitution (σ)	5.399383577	5.410837611
Weighing Parameter (β)	0.982428179	0.980455414
New Sales Tax Rate (t)	0.05855266297583	0.05839033902004
EV	5.969729613	6.697960976
EV/W	0.000202254	0.000224854
$EV/\Delta T$	0.208087602	0.208535339
CV	5.968522456	6.696455249
CV/W	0.000202213	0.000224804
$CV/\Delta T$	0.208045524	0.208488459

EV is the Equivalent Variation and *CV* is the Compensating Variation. *W* is per-capita personal income in Michigan. ΔT is an amount of sales-tax revenues from the new tax base (remote sales) after the policy change. $EV/\Delta T$ and $CV/\Delta T$ are the excess burden.

2.4.2.3 Computation of the welfare change in CES utility function

I compare the tax-evasion economy (the current sales-tax system) with the no tax-evasion economy (the new equal-revenue sales-tax system) using their excess burdens. From the earlier sections, I attain the important conclusion that the new sales-tax system which is characterized by uniform taxation is as efficient as a system with lump-sum taxation. Therefore, the new sales-tax economy is better than the current sales-tax economy, and the consumer prefers the no tax-evasion economy to the tax-evasion economy. The excess burden if the current sales-tax system is replaced with the new sales-tax system can be calculated. The $EV(q^e, V^n)$ and $CV(q^n, V^e)$ can be calculated if we assume that the current sales-tax system is changed into the new sales-tax system. ΔT (= $x_2(q^n, W)^* t^n$), is the new sales-tax revenue from the remote sales.

The EV and CV of the representative consumer in FY 2000 are \$3.85, \$5.03, and \$5.97, and his EV and CV in FY 2001 are \$4.31, \$5.65, and \$6.70, corresponding to each tax elasticity. The values of EV and CV in the CES utility function are bigger than those in the C-D utility function. EV and CV are increasing with the tax elasticity and year when we look at Table 2.6, Table 2.7, and Table 2.8.

If I interpret EV and CV as a percentage change of income, they are small numbers. EV and CV in FY 2000 and FY 2001 are about 0.01% through 0.02% of the representative consumer's income. A consumer is willing to spend 0.01% or 0.02% of her income for the new tax policy. When I use the excess burden per dollar of revenue as the measure of welfare change, they are 0.12, 0.17, and 0.21, depending on the tax elasticity. After the tax-policy change, the excess burden per-dollar revenue generated by sales-tax evasion decreases by 12 cents through 21cents.

Table 2.9 Computation of Welfare Change Using the CES Utility Function (Population Limit=2,000,000)

	2000	2001
Elasticity of Substitution (σ)	15.59081141	15.62879938
Weighting Parameter (β)	0.990219868	0.989128809
New Sales Tax Rate (t)	0.058555879	0.058397028
EV	13.90196433	15.1153939
EV/W	0.000470998	0.000507432
$EV/\Delta T$	0.870597142	0.845977606
CV	13.89541962	15.84444598
CV/W	0.000470776	0.000531907
$CV/\Delta T$	0.870187286	0.886781156

EV is the Equivalent Variation and *CV* is the Compensating Variation. *W* is per-capita personal income in Michigan. ΔT is an amount of sales-tax revenues from the new tax base (remote sales) after the policy change. $EV/\Delta T$ and $CV/\Delta T$ are the excess burden.

It is appropriate to conduct sensitivity analysis with respect to the elasticity of substitution. The results presented above are based on the elasticities that are derived from Goolsbee's estimates (2000). To give a sense of the welfare effects associated with various values of the elasticity of substitution, I use an elasticity derived from my earlier chapter (two-million population limit). The simulation results are shown in Table 2.9. When I use my results (two-million case), the elasticity of substitution is very large, and EV and CV are relatively large compared to those in Goolsbee's case. Thus, the excess burden in my case is also large such as 85 cents through 89 cents.

In the case of the C-D utility function, the elasticity of substitution between taxed general retail goods and untaxed remote-sale goods is 1. The elasticity of substitution of the CES utility function is bigger than that of the C-D utility function. This means that the representative consumer would be more likely to substitute general retail goods for remote-sales goods in the case of the CES utility function if the sales tax were imposed on remote-sale goods. After the tax-policy change, the proportion of the remote sales would be smaller in the consumer's consumption bundle, and the sales-tax revenues from remote sales would be smaller, if the CES utility function is the correct description of the consumer's preferences, rather than the C-D utility function. Therefore, the excess burden associated with the CES utility function is relatively large compared to that associated with the C-D utility function.

I can conclude from my analysis that the representative consumer prefers the new equal-revenue sales-tax system to the current sales-tax system, and that the representative consumer in the CES utility function would respond more sensitively to the tax-policy change than one in the C-D utility function would. Thus, the representative consumer with a CES utility function would be better off than one with a C-D utility function, if the sales tax were imposed on remote-sales goods.

2.5. Conclusion

In the previous sections, I estimated the welfare of the representative consumer in two cases: one represents the present case, in which sales-tax evasion on remote sales is widespread. The other is the policy scenario in which state and local governments can succeed in collecting the sales tax from remote sales.

The welfare of the representative consumer would increase as a result of the policy change. That is, if state and local governments collected the sales tax successfully from e-commerce and mail-order shopping and decreased the sales-tax rate, the consumer would prefer the no-tax-evasion economy to the tax-evasion economy, because the excess burden of the current sales-tax system is larger than that of the new equal-revenue sales-tax system. In addition, since the elasticity of substitution of the CES utility function is larger than that of the C-D utility function, the excess burden of the current sales tax system would be larger with the CES utility function than with the C-D utility function.

The motto of public finance is to broaden the tax base and to reduce the tax rate.[58] When state and local governments can collect sales tax successfully from online and mail-order purchases, they could reduce their sales-tax rates. When commodity-tax rates are the same across all goods, uniform taxation would make the economy optimal under some conditions (Sandmo, 1976 and 1974, and Atkinson and Stiglitz, 1972). In this model, I do not consider the labor-leisure choice in the problem of the representative consumer. The consumption choice of the representative consumer in my model is invariant with respect to the labor-leisure choice. This property corresponds to the

[58] Slemrod (2002) called it the first folk theorem.

conditions in which uniform taxation is optimal according to Sandmo's model (1974). That is, "if ...the utility function is weakly separable between labor and consumption goods and homogenous in consumption goods, the proportional taxation is optimal."

We have two goods (general retail goods and remote sales goods) in the CES utility function. After the tax-policy change, uniform taxation would be imposed, and we would have the uniform sales tax for all goods. As a result, the welfare of the representative consumer would increase. In the case of the C-D utility function, there are three goods: general retail goods, food and services, and remote sales goods. After the tax-policy change, general retail goods and remote sales goods would be taxed at the same rate, but food and services would not be taxed. Therefore in this model, it is not the case that all goods are taxed at the same rate, even after the policy change.[59] However, since the tax distortions are the only distortions in this model, any movement in the direction of uniformity would improve the welfare of the representative consumer, even if we don't get all the way to uniformity.

If state and local governments have ways to enforce sales and use tax from remote sales and decrease the sales and use tax rate, the economic efficiency would be improved. However, state and local governments do not have reliable ways to enforce the sale and use tax for remote sales. If I focus on this problem differently, the resource costs devoted to enforcement could be very large. Specifically, the probability of detecting tax evasion may be so low that state and local governments cannot deter sales-tax evasion by those who are engaged in online shopping and mail-order shopping. If I were to include the

[59] I investigate the excess burdens of the current sales-tax system in two-good case, and its excess burdens are about more than 3 cents. Like the CES utility function in two-good case, the uniformity would improve the welfare of the representative consumer under the C-D utility function in two-good case. Its excess burdens are smaller than those of the CES utility function.

resource costs to detect the tax evasion to my model, I could get a different result about welfare changes.[60]

The welfare simulations reported here are based on a model in which the sales tax is the only distortion. It would be possible to construct a model in which there is a labor-leisure choice, and in which income taxes and payroll taxes distort the labor-supply decision. In such a model, the sales tax would be only a small part of the overall wedge between the marginal revenue product of labor and the marginal utility of consumption. This has the potential to have a substantial effect on the welfare estimates. Building such a model is a promising avenue for future research.

[60] In a model of cross-border shopping, Lovely (1994) compares a no-enforcement equilibrium with costly evasion to an enforcement equilibrium with costly evasion, and proves that enforcement reduces welfare if administrative and uncertainty costs outweigh the benefit of consumption changes.

CHAPTER 3: CONCLUSION AND POLICY IMPLICATION

We find that the sales-tax rate is an important factor in online shopping according to Goolsbee (2000). In my model, I show that the geographic characteristics of consumers as well as the sales-tax rate are essential factors in determining the purchasing patterns of consumers. The sales-tax rate and geographic variables are not significant and do not give interesting implications when we use the whole sample. However, the empirical results with population limits tell us that the sales-tax rate is an influential factor in electronic purchases, and the geographic variables such as the sales-tax ratios and the sales-tax rate differentials affect the purchasing patterns of consumers in large metropolitan consumers.

These empirical results tell us that a consumer considers the sales-tax rate of his own county in making online purchases. The empirical results can lead us to the speculation that consumers also consider the sales-tax rates of their neighboring counties and compare the relative prices of online shopping and cross-border shopping. Another important conclusion is that consumers living in regions with high inflation rates would be more likely to make online purchases. In order to evade the increasing price levels of his or her jurisdiction, he or she could use online shopping.

In the second chapter, I estimate the welfare change that could be derived from the tax-policy change; under which state and local governments can successfully collect the sales and use tax from remote sales. A consumer's welfare can increase in the cases of both the C-D and CES utility functions if the new tax policy is adapted. The excess burden that is induced by the current sales-tax evasion is about 3 cents per dollar if we assume the C-D utility function. In the case of the CES utility function, the excess burdens are substantially larger than those of the C-D utility function.

The existence of tax evasion in remote sales distorts the decision-making of consumers and causes the additional excess burden of the sales tax. Therefore, the ideal sales-tax system is to collect sales tax from online shopping and mail-order shopping. However, it is very hard to determine which state government owns the sales-tax revenues from remote sales, if state and local governments can collect the sales tax from remote sales. It is also difficult to decide which state or local governments make online stores to collect the sales tax from consumers. According to the destination base, the state government of consumers (online shoppers) should have the authority to impose the sales tax. Therefore, online stores may collect the sales tax from consumers at the rate of the consumers' home jurisdiction, and pay it to the state or local government of consumer.

APPENDIX

Table A.1 Weighted Average Sales Tax Rates

State	County	1997	1997
Alabama		4	4
	Calhoun	5.8769	5.8769
	Jefferson	7.2091	7.2091
	Madison	8.0009	8.0009
	Tuscaloosa	5.3177	5.3177
Alaska		0	0
	Anchorage	0	0
Arizona		5	5
	Maricopa	6.9733	6.9733
	Pima	6.2647	6.2647
	Pinal	7.0333	7.0333
	Yavapai	6.6825	6.6825
	Yuma	7.1727	7.1727
California		6	6
	Alameda	8.25	8.25
	Butte	7.25	7.25
	Contra Costa	8.25	8.25
	El Dorado	7.25	7.25
	Kern	7.25	7.25
	Los Angeles	8.25	8.25
	Marin	7.25	7.25
	Merced	7.25	7.25
	Monterey	7.25	7.25
	Orange	7.75	7.75
	Placer	7.25	7.25
	Sacramento	7.75	7.75
	San Diego	7.75	7.75
	San Francisco	8.5	8.5
	San Joaquin	7.75	7.75
	San Luis Obispo	7.25	7.25
	San Mateo	8.25	8.25
	Santa Barbara	7.75	7.75
	Santa Clara	8.25	8.25
	Sonoma	7.5	7.5
	Stanislaus	7.375	7.375
	Tulare	7.75	7.75
	Ventura	7.25	7.25
	Yolo	7.25	7.25
Colorado		3	3
	Arapahoe	6.2716	6.2716
	Boulder	7.2155	7.2155
	Denver	7.3	7.3
	El Paso	5.6218	5.5151
	Jefferson	6.4877	6.4399
	Larimer	5.4156	5.8947
	Pueblo	6.7223	6.4265
	Weld	5.2355	5.2431

Table A.1 (cont'd)

State	County	1997	2001
Delaware		0	0
	Kent	0	0
	New Castle	0	0
	Sussex	0	0
District of Columbia		5.75	5.75
Florida		6	6
	Alachua	6	6
	Bay	6.5	7
	Brevard	6	6
	Broward	6	6
	Charlotte	7	7
	Clay	7	7
	Collier	6	7
	Dade	6.5	6.5
	Hernando	6	6.5
	Hillsborough	6.75	6.75
	Lake	7	7
	Lee	6	6
	Manatee	6	6
	Marion	6	6
	Okaloosa	6	6
	Orange	6	6
	Osceola	7	7
	Palm Beach	6	6
	Pasco	6	6
	Pinellas	7	7
	Polk	6	6
	Sarasota	7	7
	Seminole	7	7
Georgia		4	4
	Clayton	6	6
	Cobb	4	5
	Dekalb	7	7
	Fulton	7	7
	Gwinnett	6	6
Hawaii		4	4
	Hawaii	4	4
Illinois		6.25	6.25
	Lasalle	6.25	6.5
	Macon	7.1458	7.1421
Indiana		5	5
	Hamilton	5	5
	Lake	5	5
	Laporte	5	5
	Porter	5	5
	St.Joseph	5	5

Table A.1 (cont'd)

State	County	1997	2001
Iowa		5	5
	Black Hawk	6	7
	Linn	5.0014	5.0045
	Scott	6	7
Kansas		4.9	4.9
	Shawnee	5.6436	6.5330
Kentucky		6	6
	Kenton	6	6
Louisiana		4	4
	E.Baton Rouge	8	9.016705
	Calcasieu	8.6489	8.6523
	Jefferson	8.75	8.75
	Ouachita	8.2645	8.5230
Maine		6	5
	Kennebec	6	5
Maryland		5	5
	Baltimore	5	5
	Carroll	5	5
	Frederick	5	5
	Harford	5	5
	Howard	5	5
	Montgomery	5	5
	Prince George's	5	5
	Washington	5	5
Michigan		6	6
	Berrien	6	6
	Genesee	6	6
	Jackson	6	6
	Macomb	6	6
	Monroe	6	6
	Washtenaw	6	6
Minnesota		6.5	6.5
	Anoka	6.5	6.5
	Dakota	6.5	6.5
	Hennepin	6.6687	6.6714
	Ramsey	6.7659	6.7810
	St.Louis	6.9408	6.9591
	Washington	6.5	6.5
Missouri		4.225	4.225
	Jefferson	6.0348	6.0843
	St.Louis	6.3262	6.5656

Table A.1 (cont'd)

State	County	1997	2001
Nebraska		5	5
	Lancaster	6.3599	6.3519
Nevada		6.5	6.5
	Clark	7	7.25
	Washoe	7	7.25
New Jersey		6	6
	Bergen	6	6
	Burlington	5.9137	5.9154
	Camden	5.4989	5.5290
	Cumberland	3.8458	3.8307
	Essex	4.1927	4.2662
	Hudson	3.6811	3.7225
	Hunterdon	6	6
	Mercer	5.2273	5.2696
	Middlesex	5.7409	5.7280
	Monmouth	5.7683	5.7647
	Morris	6	6
	Ocean	5.7757	5.7882
	Passaic	4.6947	4.6683
	Somerset	6	6
	Union	5.0553	5.0332
New Mexico		5	5
	Dona Ana	6.1107	6.1069
New York		4	4
	Bronx	8.25	8.25
	Chautauqua	7	7
	Dutchess	7.25	7.25
	Kings	8.25	8.25
	Monroe	8	8
	Nassau	8.5	8.5
	New York	8.25	8.25
	Orange	7.25	7.25
	Oswego	7	7
	Queens	8.25	8.25
	Richmond	8.25	8.25
	St.Lawrence	7	7
	Suffolk	8.25	8.5
	Ulster	7.75	7.75
	Westchester	7.3494	7.3543
North Carolina		4	4
	Cumberland	6	6
	Forsythe	6	6
	Mecklenburg	6	6.5
	New Hanover	6	6
	Pitt	6	6
	Robeson	6	6
	Wake	6	6

Table A.1 (cont'd)

State	County	1997	2001
North Dakota		5	5
	Cass	5.8624	6.3721
Ohio		5	5
	Clermont	6	6
	Columbiana	6	6
	Cuyahoga	7	7
	Hamilton	6	6
	Lake	5.75	5.75
	Lorain	5.75	5.75
	Medina	5.5	5.5
Oklahoma		4.5	4.5
	Tulsa	7.7433	7.8216
Oregon		0	0
	Jackson	0	0
	Lane	0	0
Pennsylvania		6	6
	Allegheny	7	7
	Beaver	6	6
	Berks	6	6
	Bucks	6	6
	Butler	6	6
	Chester	6	6
	Delaware	6	6
	Erie	6	6
	Fayette	6	6
	Lancaster	6	6
	Montgomery	6	6
	Philadelphia	7	7
	Washington	6	6
	Westmoreland	6	6
	York	6	6
S.Carolina		5	5
	Horry	5	5
	Lexington	5	5
	Richland	5	5
	York	5	6
S.Dakota		4	4
	Minnehaha	5.7498	5.8342
Tennessee		6	6
	Montgomery	8.5	8.5

Table A.1 (cont'd)

State	County	1997	2001
Texas		6.25	6.25
	Brazoria	7.5980	7.6450
	Cameron	7.7986	7.7295
	El Paso	8.1173	8.0555
	Fort Bend	7.6306	7.4083
	Galveston	7.8235	7.8134
	Hidalgo	7.6305	7.5826
	Lubbock	7.7490	7.7491
	Midland	7.5833	7.7756
	Tarrant	7.9484	7.9998
	Webb	7.9571	8.1686
Utah		4.75	4.75
	Utah	6.0040	6.2335
Virginia		3.5	3.5
	Chesterfield	4.5	4.5
	Fairfax	4.5	4.5
	Henrico	4.5	4.5
	Prince William	4.5	4.5
	Alexandria City	4.5	4.5
	Hampton City	4.5	4.5
	Newport News City	4.5	4.5
	Norfolk City	4.5	4.5
	Virginia Beach City	4.5	4.5
Washington		6.5	6.5
	Clark	7.6017	7.7126
	Pierce	8.2544	8.3552
	Spokane	7.9500	7.9539
	Thurston	8	8
	Whatcom	7.6615	7.7665
Wisconsin		5	5
	Brown	5	5.5
	Dane	5.5	5.5
	Racine	5.1	5.1

Table A.2 Populations of MSAs

MSA	1997	2001
Los Angeles, CA PMSA	9,126,131	9,519,338
New York, NY PMSA	8,650,056	9,314,235
Philadelphia, PA-NJ PMSA	4,942,723	5,100,931
Washington, DC-MD-VA-WV PMSA	4,601,800	4,923,153
Detroit, MI PMSA	4,441,551	4,467,658
Houston, TX PMSA	3,841,934	4,177,646
Atlanta, GA MSA	3,632,206	4,112,238
Phoenix-Mesa, AZ MSA	2,841,395	3,251,876
Minneapolis-St. Paul, MN-WI MSA	2,795,024	2,968,806
Orange County, CA PMSA	2,760,948	2,846,289
San Diego, CA MSA	2,722,060	2,813,833
Nassau-Suffolk, NY PMSA	2,659,447	2,753,913
St. Louis, MO-IL MSA	2,557,804	2,603,607
Baltimore, MD PMSA	2,474,658	2,552,994
Tampa-St. Petersburg-Clearwater, FL MSA	2,225,002	2,395,997
Oakland, CA PMSA	2,271,696	2,392,557
Pittsburgh, PA MSA	2,358,695	2,359,388
Miami, FL PMSA	2,132,112	2,253,362
Cleveland-Lorain-Elyria, OH PMSA	2,229,246	2,250,871
Denver, CO PMSA	1,901,102	2,109,282
Newark, NJ PMSA	1,942,813	2,032,989
Portland-Vancouver, OR-WA PMSA	1,790,675	1,918,009
San Francisco, CA MSA	1,671,200	1,731,183
Fort Worth-Arlington, TX PMSA	1,554,162	1,702,625
San Jose, CA PMSA	1,621,660	1,682,585
Cincinnati, OH-KY-TN PMSA	1,606,655	1,646,395
Orlando, FL MSA	1,464,182	1,644,561
Sacramento, CA PMSA	1,527,825	1,628,197
Fort Lauderdale, FL PMSA	1,476,860	1,623,018
Indianapolis, IN MSA	1,504,939	1,607,486
Norfolk-Virginia Beach-Newport News, VA-NC MSA	1,549,527	1,569,541
Las Vegas, NV-AZ MSA	1,260,307	1,563,282
Charlotte-Gastonia-Rock Hill, NC-SC MSA	1,350,679	1,499,293
Bergen-Passaic, NJ PMSA	1,333,504	1,373,167

The source of this table is the U.S. Census Bureau (http://www.census.gov). The populations of MSAs in 1997 are populations estimates and the numbers in 2001 are extracted from the United States Census 2000. MSA and PMSA mean Metropolitan Statistical Area and Primary Metropolitan Statistical Area.

Table A.2 (cont'd)

MSA	1997	2001
New Orleans, LA MSA	1,307,184	1,337,726
Greensboro-Winston Salem-High Point, NC MSA	1,153,179	1,251,509
Raleigh-Durham-Chapel Hill, NC MSA	1,050,697	1,187,941
Middlesex-Somerset-Hunterdon, NJ PMSA	1,104,576	1,169,641
West Palm Beach-Boca Raton, FL MSA	1,014,725	1,131,184
Monmouth-Ocean, NJ PMSA	1,079,186	1,126,217
Jacksonville, FL MSA	1,029,416	1,100,491
Rochester, NY MSA	1,083,427	1,098,201

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