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Electronic Commerce and Tax Competition:
When Consumers Can Shop Across Borders and On-Line

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Abstract

1 Introduction

As little as five years ago, the Internet was a little known phenomenon and a non-issue in terms of government policy. How quickly times change. In the United States, the Internet Tax Freedom Act establishes a moratorium on Internet taxes through October, 2006[1]. Currently, online sales of physical goods are treated like mail-order catalog sales. If a firm does not have what is known as nexus (a substantial physical presence) in the state where the customer lives, they are not required to collect sales tax on the purchase[2]. Consumers in most states are officially responsible for sending in use taxes on these purchases, however there is little or no enforcement of this[3]. Sales tax revenue, therefore, is generally not collected on these sales. As a result, state governments are concerned about dwindling sales tax revenues due to increasing tax-free electronic commerce sales. Currently, sales taxes account for on average 33% of revenues at the state level and 11% of revenues at the local level in the United States (U.S. General Accounting Office).

Electronic commerce (e-commerce) sales are defined by the U.S. Department of Commerce as \sales of goods and services over the Internet, an extranet, Electronic Data Interchange, or other online system. Payment may or may not be made online." Retail e-commerce sales were first reported by the U.S. Department of Commerce for the last quarter of 1999. The most current estimate puts e-commerce sales during the second quarter of 2000 at $5.518 billion (0.68 percent of total retail sales), an increase of 5.3 percent over the previous quarter (Census Bureau). While currently small, the growth of e-commerce sales is dramatic: one estimate puts e-commerce business-to-consumer sales at $454 billion by 2004, increasing the potential for revenue losses at the state and local level (Forrester Research).

The current debate over whether or not e-commerce sales should be taxed

[1] The original expiration date of October, 2001, was extended by Congress.

[2] For a good explanation of nexus and implications for electronic commerce, see Fox and Murray (1997) and Goolsbee and Zittrain (1999).

[3]

focuses on several issues. Those favoring a tax assert that the introduction of an electronic commerce tax would do irreparable harm to the growth of the Internet as consumers return to main-street shops. Their opponents cite concerns of lower state government revenues due to increasing e-commerce sales, the resulting decrease in public good provision, and issues regarding equity.

This paper examines several issues relevant to the current e-commerce tax debate. A framework is developed in which the potential revenue losses due to increasing e-commerce sales can be examined. This model can also describe the emergence of e-commerce. In addition, equity issues are explored by considering a case in which consumer incomes vary. This paper is not discussing how taxing purchases made using the Internet would affect its growth. It is, however, an

The emergence of electronic commerce over the past several years can be described within this model. The cost of computing technology has decreased substantially relative to income within the last ten years. This partly describes the emergence of e-commerce, as consumers find the equipment necessary to shop online more affordable. The Internet environment has also become more accepted by shoppers, given technological improvements in security and advancements in ease of use. These all function to lower the costs of shopping online, represented here by a single fixed cost. While there are certainly supply-side issues as well, the acceptance and willingness of consumers to shop online is a crucial element in the success of e-commerce.

Governments in each region essentially compete for consumers by setting their tax rates, taking into account that higher tax rates will drive some consumers away and therefore lower their tax base. This tax competition framework is useful because it allows an examination of the interaction between governments before and after the participation of the Internet region. The Internet region will "enter" this model as long as there are some consumers who are willing to shop there. This will occur if, for some consumers, the benefit from shopping online (the utility they receive there) outweighs the cost (the cost of accessing the Internet). It is assumed that the Internet firm is located in a separate, remote, region. This modeling choice is a natural starting place because the focus here is on sales to consumers by firms who do not have a physical presence, or nexus, in the consumer's state. Therefore, given a sufficient decrease in the fixed cost of shopping online relative to income, this framework predicts the following. The Internet region will choose to "enter" the model, moving us from a 2-region conventional-business only model to a 3-region model that sustains both conventional business and electronic commerce.

In the United States, taxes on Internet purchases are essentially zero due to nonenforcement of use taxes[4]. Internet taxes can potentially be collected based on either a origin (location of purchase) or destination (location of consumer)

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[4]

principle. Because Internet taxes are currently zero and therefore consumers can purchase online without paying taxes, this model assumes origin taxation on all purchases. The European Union has also implemented the Value Added Tax (VAT) on purchases within Member States using the origin principle, providing additional incentives for analysis of a potentially non-zero origin tax[5].

This model provides a framework in which the potential revenue losses associated with increasing e-commerce sales can be examined. Each region chooses tax rates endogenously, leading to potentially nonzero tax rates for the Internet region. Comparisons of tax rates, bases, and revenues are made for the following three cases: no Internet region participation; Internet region participation with endogenously chosen tax rate; and Internet region participation with zero online tax rate (sometimes referred to as the \status quo"). The case in which the Internet region participates with a zero tax rate will always result in lower tax rates, bases, and therefore revenues than when the Internet region participates and sets a nonzero tax rate. The general findings of this tax competition model (in which all three regions choose tax rates endogenously) are therefore only amplified if we consider the status quo in the United States (zero Internet tax). In order to examine tax revenues in each of these cases, recall that the Internet firm is located in a separate region. Therefore, there exist 3 regions in the two cases in which the Internet participates and 2 regions otherwise. One must therefore examine what happens to *total* revenue collections across all regions in order to truly pin down the effects of Internet-induced competition.

Consumers have unit demands for a single good. The focus is therefore given to *where* the purchase is made, rather than *if* the good is purchased (and how much). A Hotelling style model is constructed in which consumers are uniformly distributed along a line connecting two conventional shopping centers

[5] The European system is complicated, as there are many rules governing so-called \distance selling." If a seller exceeds a threshold level of sales to private consumers in another Member State (that threshold being set by the country in which

or regions. If they choose to shop conventionally, they must travel to one of the two regions. Travel is costly in terms of time, and therefore consumers would like to find alternative means of acquiring goods. The Internet provides this alternative, although there is a fixed cost associated with Internet shopping. This fixed cost can be thought of as access costs that must be paid in order to shop online, including computer access, time and money spent learning how to use a computer, getting connected to the Internet, etc. Once paid, the fixed cost allows the online purchase to be made without travel costs: the good is shipped to them directly. This convenience is most valued by the consumers who live in remote areas, far away from either conventional shopping center. They incur the highest travel costs associated with conventional shopping and therefore are the most likely to pay the fixed cost and shop online.

An analysis of the cases with Internet shopping versus the model without e-commerce shows the following. Given a sufficient decrease in the fixed cost of online shopping, consumers in remote regions will begin to shop in the Internet region. As a result of this, the tax base in both conventional regions will decrease relative to the case in which the Internet region does not participate. The optimal tax rates are also lower when faced with competition from the Internet region[6]. This is because consumers face a choice of *where* to buy, i.e., they can shop across borders. In the model without e-commerce, each conventional region competes with its neighbor, the other conventional region. Since the Internet is non-geographic in nature (consumers don't incur travel costs to shop there), it can be thought of as a very close neighboring region. In the model with Internet commerce, the new \neighboring" region for both conventional regions becomes the Internet. The costs of shopping across the border are now much lower, leading to increased competition for consumers and lower tax rates. Since revenue is comprised of the tax rate times the tax base, lower bases and rates necessarily mean that tax revenues in both conventional regions will be lower with a competing Internet region than before. Keeping in mind that the

[6] Recall that this assumes that the Internet region is setting tax rates endogenously. The case where the Internet tax is zero will result in even lower tax rates, bases, and revenues.

number of regions changes, examination of total revenue collections across all regions is necessary. Total revenues in all regions fall with an endogenously chosen Internet tax rate. Total revenues are even lower in the case where the Internet region has a zero tax. This is clearly due to the competition between governments as a result of Internet shopping. This result suggests that the concerns of state governments are potentially justified.

President Clinton and others have focused attention on the "Digital Divide". The idea of the digital divide is that the rich and educated have the best access to computers and the Internet. It is these people, therefore, who will thrive in today's high-tech labor market. More importantly, the poor have limited access to computers and the Internet. If they cannot learn the computer skills needed to find employment in these high-paying, high-growth sectors, they will necessarily fall further and further behind (National Telecommunications and Information Administration). This motivates an examination of the equity issues relating to an e-commerce sales tax, which is achieved by allowing consumer incomes to vary. More high-income consumers shop online than low-income consumers. This is intuitive because they have a higher willingness to pay the fixed cost to shop online and their time is worth more to them (making conventional shopping less attractive). Therefore, if the online tax rate is lower than conventional tax rates, the average rich person will pay relatively less of their income in sales tax than the average poor person. This would make an Internet sales tax regressive in this framework. However, with further decreases in the fixed cost of online shopping, the tax in the online region increases, making a sales tax less regressive over time. The sales tax rates and bases in this model are both a function of income distribution. Higher income inequality leads to lower optimal tax rates in all regions. However, the tax bases are ambiguous with respect to income distribution. Therefore, a change in income inequality will cause an undetermined change in revenues in this simple framework.

tially dispersed consumers, abstracting from the price-setting behavior of firms, assuming perfect competition instead of monopoly, and considering the tax competition that arises when regional governments choose tax rates.

A Hotelling style spatial differentiation model is developed that describes the geographic nature of two conventional regions (Hotelling 1929). An electronic region where consumers can shop online is then added. This new region is non-geographic in nature: consumers do not incur travel costs when they shop there. In order to shop online, however, consumers must pay a fixed cost associated with online access. This fixed cost can be thought of as the cost of accessing a computer, the time and money spent learning to use it, the costs of setting up internet service, etc. Consumers are uniformly distributed along a line from 0 to 1, their location denoted by the parameter . Consumers are identical and valuable at higher incomes. A further utility loss occurs because the amount t_1 must be paid to acquire the good. Similarly, the consumer may shop in region 2. In order to purchase in region 2, they must travel to 1. Again, the time cost causes a utility loss and then they face t_2 when they arrive. To shop online, the consumer faces both the xed cost of access, T, and the price online t_3. There is, however, no travel cost associated with this purchasing option. T encompasses all costs associated with shopping online, including having the good shipped to the consumer's home.

Utility with the purchase of one unit is therefore:

$$U = \begin{cases} - \quad - t_1 & : \quad \text{when buying in region 1} \\ -(1 - \quad) \quad - t_2 & : \quad \text{when buying in region 2} \\ - T - t_3 & : \quad \text{when buying in region 3} \end{cases}$$

where is income, is the location of the consumer, and t represents the price the consumer faces in each region. The parameter is used to scale up incomes to the point where each consumer decides to make a purchase. This is because focus is given to *where* and not *if* the purchase is made. The important feature here is that there is a di erence in convenience (in terms of time) between online shopping and conventional shopping. This is re ected in the utility structure by making the time cost dependent on income for conventional shopping and the cost T *not* dependent on income for online shopping. This is one of many potential modeling choices. As long as there is a lower opportunity cost (in terms of time) for online shopping versus conventional shopping, this can be re ected by setting the time cost for online shopping to zero and the time cost for conventional shopping to a positive number.

The model abstracts from possible cost advantages associated with economies of scale in production that would likely be associated with online merchants. Perfect competition is assumed in all regions, implying that rms would charge marginal cost. We further assume that marginal costs are identical in all regions. For simplicity, the marginal cost is set to zero. As a result, the consumer price in each region is simply the tax rate. Firm location is also assumed xed.

from shopping in region 1 (or 2) than shopping online even given a tax rate of zero in region 3:

$$U_1(\quad = \frac{1}{2}; t_1) > U_3(\quad = \frac{1}{2}; t_3$$

welfare maximizing case.

Given that T is sufficiently low relative to income, the Internet region has business and results are derived for the three-region model with Internet commerce in which all three regions set tax rates endogenously.

Region 1's maximization problem is:

$$\max_{t_1} R_1 = t_1 \int_0^{\bar{\_}} f(\ )\, d \qquad (1)$$

where _ is the location of the consumer who is indifferent between shopping in region 1 and online. Setting the utility from shopping in region 1 equal to the utility from shopping in region 3 and solving for yields

o14 25th50F17 11.96 11.96ppTf8.709285 TD[1590(r8.l9235 TD[159 TD0 TD96ppT5)t

$$\_ = \frac{T + t_3 - t_1}{\ } \qquad (2)$$

Note that increasing t_3 will increase _, meaning that the number of people shopping online will decrease if region 3 increases its tax rate. If region 1 increases their tax rate, this will lower _ (increase the number of people shopping online and decrease those shopping in region 1). Each region takes into account that increasing their tax rate will lower their tax base, as consumers at the margin will decide to shop in the neighboring region instead.

Solving this maximization problems yields a reaction function for t_1 which is linear with respect to both the neighboring region's tax rate (where the neighbor is the region 3, the Internet) and the fixed cost of shopping online, T.

$$t_1 = \frac{T + t_3}{2}. \qquad (3)$$

and the following reaction function for t_3 results:

$$t_3 = \quad -2T + t_1 + t_2$$

Without e-commerce	*With e-commerce,* $t_3 > 0$	*With e-commerce,* $t_3 = 0$
$t_1 = t_2 = \frac{t_2 +}{2}$	$t_1 = t_2 = \frac{T + t_3}{2}$	*n=a*
n/a	$t_3 = \frac{2T + t_1 + t_2}{4}$	n/a

Reaction functions are not reported here for the case in which $t_3 = 0$ because these functions collapse into equilibrium values. Equilibrium tax rates are discussed shortly.

Figure 2 shows the reaction function of $t_1(t_N)$, where N denotes the neighboring region. This gure only looks at the case without Internet commerce and the case in which the Internet tax is chosen endogenously. Examination of the reaction function shows that, for a given tax rate set by the neighboring region, the optimal rate in two-region model without Internet commerce is always above the optimal rate in the three-region model with Internet commerce. The slope of the reaction function remains the same, i.e. each region will react to changes in a similar way in either model.

In order to assess whether or not the tax rates will be lower with electronic commerce than without, the Nash equilibrium tax rates for the conventional regions in all cases are examined.

Equilibrium tax rates:

Without e-commerce	*With e-commerce,* $t_3 > 0$	*With e-commerce,* $t_3 = 0$
$t_1 = t_2 =$	$t_1 = t_2 = \frac{2T +}{6}$	$t_1 = t_2 = \frac{T}{2}$
n/a	$t_3 = \frac{T}{3}$	$t_3 = 0$

Several comparisons are of interest here. First, for the conventional tax rates in the model with endogenous (i.e. $t_3 >$

case, it must be the case that $\frac{T}{2} < \frac{2T +}{6}$. This implies that $T <$, which is the same as the equilibrium condition. Therefore, for any equilibrium that exists, the following ranking of tax rates will exist: t_1(no Internet)> t_1(Internet with $t_3 > 0$)> t_1(Internet with $t_3 = 0$). Therefore, the general results of this model in which t_3 is endogenously set will be reinforced if we consider the status quo in which $t_3 = 0$.

The tax rate set by conventional governments is only part of the concern of state tax o cials. Figure 3 shows what happens to the tax base of region 1 (a similar statement can be made about the tax base of region 2) both with and without Internet commerce. As long as an equilibrium exists in which all three

The tax rates set in conventional regions fall from 1 to $\frac{1}{3}$ as a result of a competing Internet region. In the case with a zero online tax, t_1 is even lower: $\frac{1}{4}$. Tax bases are also lower in the case with a competing Internet region, falling from $\frac{1}{2}$ before Internet commerce to $\frac{1}{3}$ with an endogenous Internet tax to $\frac{1}{4}$ with a zero Internet tax. Total revenues (across all regions) are also reported. Without Internet commerce, total tax revenues are = 1. Revenues are lower with a competing Internet region, although the competitive rate e ect is large (revenues fall from 1 to 0:277). Consideration of the status quo shows an even greater competitive e ect, with total revenues at a very low 0:125, one-eighth the level before Internet commerce. It should be noted that this numerical example does not give general results that be extended the rest the model. In general, the ranking the revenues be done but the magnitude of the revenues in relationship to each other cannot be speci ed.

3 Social Welfare Maximization

One might argue that revenue maximization would be an unlikely objective function for the government in any region. It is shown thatthe revenuemaxi-mizating Nash values foundearlier are a special case of the social welfare max-imizing results derivedhere. The revenuemaximization problem can therefore approximate the more complicated social welfare problem since all qualitative results will be identical.

Suppose that the conventional regions 1 and 2 aim to maximize the social welfare of the consumers who live there. Consumers between 0 and 1=2 live in region 1, and consumers between 1=2 and 1 live in region 2. The non-geographic nature of the Internet precludes consumers from living there. Because there are no consumers who would bene t from the provision of a public good, it is assumed thatregion 3'sgovernmentcontinues maximize revenue. This makes the Internet similar to a tax haven, a region thattypically has unusually low tax rates and a very small population. Thinking about why tax rates in tax havens are so low, the demand for public goods is relatively low because there are so few people living there. The possibility of region three maximizing social welfare is left as an extension.

Social welfare is defined as simply the sum of individual utilities for people who live in a specific region. Continuing with the assumption that $\underline{\ } < \bar{\ }$, i.e., that there is Internet shopping, the maximization problems for regions 1 and 2 become the following:

$$\max_{t_1} SW_1 = \int_0^{\underline{\ }} [(\; - \; - t_1) + G(R)]\, d \; + \int_{\underline{\ }}^{1/2} [(\; - T - t_3) + G(R)]\, d \qquad (9)$$

$$\max_{t_2} SW_2 = \int_{\underline{\ }}^{1} \{[\; - (1 - \;) \; - t_2] + G(R)\}\, d \; + \int_{1/2}^{-} [(\; - T - t_3) + G(R)]\, d \qquad (10)$$

For region 1, the first integral is the utility from private good consumption plus public good consumption of region 1 residents who shop in region 1. The second integral for region 1 includes the utility of region 1 residents who shop online. In this framework, region 1 still cares about their utility, despite the fact that their tax revenues are paid to region 3's government.

Each government uses revenues to finance a public good, which add to utility through $G(R)$. The public good adds to utility in a linear and separable way. For simplicity, the marginal benefit of the public good is assumed to be constant. This allows for a closed-form solution to the social welfare problem and a straightforward comparison between the social welfare maximizing equilibrium tax rates and those derived earlier. This implies that $\frac{\partial G}{\partial R} = k$, where $k > 2$. For a discussion of why $k > 2$, please refer to the appendix. Since the status quo where $t_3 = 0$ causes the reaction functions of both conventional regions to collapse, attention here is given to the case where t_3 is endogenously chosen. It should be kept in mind that the results in which $t_3 = 0$ are similar to the case in which t_3 is endogenously chosen.

Reaction functions:

Revenue Maximization	*Social Welfare Maximization*
$t_1 = \frac{T + t_3}{2}$	$t_1 = \frac{(T + t_3)}{2}\frac{(k-2)}{(k-1)}$
$t_2 = \frac{T + t_3}{2}$	$t_2 = \frac{(T + t_3)}{2}\frac{(k-2)}{(k-1)}$
$t_3 = \frac{-2T + t_1 + t_2}{4}$	$t_3 = \frac{-2T + t_1 + t_2}{4}$

The reaction functions in the social welfare case are a function of k, the marginal bene t of the public good. As k increases, the consumers care more about the level of the public good, i.e., the public good is valued in utility more like a private good. The maximization of tax revenue is equivalent to the social welfare maximization when $k \to \infty$. As k approaches in nity, it is as if they have been given a lump sum tax rebate, which could be used for private goods consumption.

Nash values:

Revenue Maximization	*Social Welfare Maximization*
$t_1 = \frac{2T + }{6}$	$t_1 = \frac{(2T + \ )}{2}\frac{(k-2)}{(3k-2)}$
$t_2 = \frac{2T + }{6}$	$t_2 = \frac{(2T + \ )}{2}\frac{(k-2)}{(3k-2)}$
$t_3 = \frac{-T}{3}$	$t_3 = \frac{(k-1) \quad - kT}{3k-2}$

In the limit, as $k \to \infty$, the social welfare maximizing solutions for the reaction functions and Nash values approach the revenue maximizing values. For the Nash values above, applying l'Hôpital's rule[9], one has

[9] the in nity over in nity case

$$\lim_{k \to \infty} \frac{(2T + \quad)}{2} \frac{(k - 2)}{(3k - 2)} = \frac{(2T + \quad)}{6}$$

$$\lim_{k \to \infty} \frac{(k - 1) \quad - kT}{3k - 2} = \frac{\quad - T}{3} \tag{11}$$

Examination of figure 4 also shows that, as k approaches infinity, the social welfare maximizing reaction functions of the conventional regions approach the reaction functions from the revenue maximization setup. Figure 4 also shows

Using the utility functions described above, setting the utility in region 1 equal the utility in region 2 allows the calculation of the location of who is indi erent between shopping region 1 and online. This yields the revenue-base cuto values of _:

$$
\begin{aligned}
\_{L} &= \frac{1}{\ _L}(T + t_3 - t_1) \\
\_{H} &= \frac{1}{\ _H}(T + t_3 - t_1) \qquad (13)
\end{aligned}
$$

As in the one-income case, increases in the tax rate for region 1 will lead to a decrease in their tax base (as more people shop online). This is true for both high- and low-income consumers. Similarly, increases in region 3's tax rate or T will cause fewer people to shop online. Increases in either high or low incomes where the limits of integration are determined by the tax base cuto levels of calculated above. Again referring to gure 5, the tax base for region 3 is given by the horizontal distance $\underline{\ }_L$ to $\overline{\ }_L$ for the low-income base and $\underline{\ }_L$ to $\overline{\ }_H$ for the high-income base.

Each region then maximizes revenues, taking into account that an increase in their tax rate will lower their tax base, i.e. change $\overline{\ }$ and/or $\underline{\ }$ for both the high- and low-income shopper. Solving each of these maximization problems yields the following rst order conditions:

$$t_1 = \frac{T + t_3}{2}$$
$$t_2 = \frac{T + t_3}{2}$$
$$t_3 = \frac{_P}{2\ _S} + \frac{t_1 + t_2 - 2T}{4} \qquad (17)$$

where $_P = \ _L * \ _H$ (product of the s) and $_S = \ _L + \ _H$ (sum of the s). These represent the reaction functions for each region. It can easily be shown that, setting $_L = \ _H$ caus.11 TD4 -251.66 l ewh TD[(sho)27A(thelo)equilibri4(of)g loorde65

Solving the set of rst order conditions above in equation 17 yields the following Nash equilibrium tax rates:

$$t_1^A = t_2^A = \frac{{}_P}{3\;{}_S} + \frac{T}{3}$$
$$t_3^A = \frac{2\;{}_P}{3\;{}_S} - \frac{T}{3} \qquad (19)$$

where superscript \A" denotes that this is regime A, the candidate Nash equilibrium. Other potential regimes are explored in the deviation analysis mentioned above (located in the appendix). Symmetry between the conventional regions continues to guarantee that the tax rates are equal in regions 1 and 2. Of interest here is both the optimal tax rates in the electronic region versus the conventional regions and the fact that the optimal tax is a function of the distribution of income, ${}_P$, for a given ${}_S$.

4.2 Online Tax Rate versus the Conventional Tax Rates

Since more rich consumers shop online than low-income consumers, the taxes paid by consumers in both the online and conventional markets are of interest. The Nash equilibrium tax rates are given by equation 19. The online tax rate will be lower when $t_3^A = \frac{2\;{}_P}{3\;{}_S} - \frac{T}{3} < t_1^A = \frac{{}_P}{3\;{}_S} + \frac{T}{3}$. This occurs when $\frac{{}_P}{2\;{}_S} < T$.

Figure 6 shows the optimal tax rates in both the conventional and online regions as a function of the xed cost of shopping online. With a su ciently high xed cost of shopping online relative to income, the Internet region will not \enter" the model. This occurs to the right of the point where $T = \frac{2\;{}_P}{{}_S}$[13]. Starting from this situation, a decrease in T holding incomes constant is necessary before the electronic region will enter and a three-region model with sustainable e-commerce exists. Region 3 will participate but set a zero tax rate when $T = \frac{2\;{}_P}{{}_S}$. A further decrease in T will cause region 3 to set a relatively low tax rate in order to continue to lure customers from across the borders. As the xed

[13] Recall the discussion regarding the di erence between region 3's tax rate between zero and there being no threat of entry from region 3.

cost of shopping online continues to decline, region 3 sees additional increases in their tax base and therefore the incentive to set a low tax rate declines.

In the case where $_L = 1$, $_H = 2$, and $T = 1{=}2$, this implies that $t_3^A < t_1^A$ because 1=3 < 1=2. Holding xed all incomes, a lower T will cause an increase in t_3^A. With T su ciently low, i.e. = 1=3[14], the online tax rate would equal the conventional tax rate. Further decreases in T would cause the online tax rate to exceed the conventional tax rate.

Given that more high-income consumers shop online than low-income, the tax that the average high-income person pays is a smaller percentage of their income than that of the average low-income person. In general, also, there is concern about the \tax break" going to the rich because currently the online tax is zero. This can be represented in this model by the case where $T = \frac{2\ _P}{_S}$. Over time, technological progress would further decrease T relative to income, leading to increases in the optimal tax of the Internet region. Therefore, while an Internet tax may be regressive at rst, future technological advances that continue to lower the cost of computing will change the nature of this tax over time.

4.3 Optimal Taxes, Revenues, and Income Distribution

Examination of equation 19 shows that, for a given level of total income in the economy, $_S$, a change in $_P$ will change the equilibrium tax rates in all three regions. In order to perform comparative statics, de ne $_L = (\ _S - \ _H)$. Increasing inequality is therefore represented by increasing $_H$, which in this context would lower $_L$ su ciently to leave $_S$ unchanged. Consider the case in which $_L = 1$, $_H = 2$, and $T = \frac{1}{2}$[15].

For a given $_S$, $_P$ will be maximized the closer $_L$ and $_H$[16]. So, increasing income inequality can be represented by a decrease in $_P$. Comparative statics show that increasing/decreasing $_P$ leads to an increase/decrease in all regions'

[14] In general when $T < \frac{P}{2\ S}$

[15] Recall that these values are consistent with the existence of the candidate Nash equilibrium

[16] e.g. taking $_S{=}3$, compare $\frac{1}{P} = 2$ when $_L = 1$ and $_H = 2$ to $\frac{2}{P} = 2{:}24$ when $_L = 1{:}4$ and $_H = 1{:}6$

tax rates, and therefore higher income inequality leads to lower tax rates everywhere. Equivalently, the more similar high- and low-incomes, the higher tax rates in all regions. Figure 7 shows the reaction functions from equation 17 . Increasing $_P$ shifts the reaction function of region 3 down, leading to a decrease in the equilibrium tax rates in all regions.

An understanding of tax revenues as a function of income equality changes requires examination of how the high- and low-income tax bases change in each region. Increasing inequality leads to an increase in $_H$ and a decrease in $_L$. Equations 13 and 15 give the revenue cut-off levels of for both the high and low-income consumers as a function of tax rates. For example,

$$\frac{\partial \_L}{\partial \ _H} = \frac{T + t_3 - t_1}{{}^2_L} \qquad (20)$$

This implies that the change in the tax base will depend on the relative price of goods in both regions 1 and 3. $T + t_3$ is the final user cost of purchasing 1 unit in region 3, as this includes the fixed cost and the final payment for the good.

Examination of equation 19 shows that the final cost of the good online will always be twice as high as the cost of the good in either conventional region. That is,

$$T + t_3 = T + \frac{2 \ _P}{3 \ _S} - \frac{T}{3} = 2 \left(\frac{_P}{3 \ _S} + \frac{T}{3} \right) = 2t_1 = 2t_2 \qquad (21)$$

Therefore, each region will see the following effects from an increase in income inequality:

Region	*Low-Income Base*	*High-Income Base*
Regions 1 and 2	Increase	Decrease
Region 3	Decrease	Increase

Increases in income inequality, therefore, lead to ambiguous changes in tax revenue in each region even in this simple setting. A more complete investigation of the effects of income inequality would be useful in a setting where income is endogenously determined.

Examination of the revenues in each region also shows the ambiguity with respect to $_P$ and therefore income distribution.

$$R_1 = R_2 = \frac{T^2 \ {}_S}{9 \ {}_P} + \frac{{}_P}{9 \ {}_S} + \frac{2T}{9}$$

$$R_3 = \frac{2}{9} \cdot \frac{(2 \ {}_P - \ {}_S T)^2}{{}_P \ {}_S} \tag{22}$$

Setting ${}_L = {}_H$, this collapses almost completely to the one-income case shown in equation 8. In the original model, $R_1 = \frac{(2T + \ )^2}{36}$. In this case, revenue would be twice that much, seeing as though the number of residents in the model has doubled.

5 Conclusions and Extensions

This model can describe the emergence of e-commerce through a decrease in the fixed cost of shopping online relative to income. Given a sufficient decrease in this cost, the electronic region can \enter" and attract a tax base if they set relatively low tax rates. As the fixed cost of shopping online continues to decrease, increased usage of the Internet as a way of shopping is expected.

This model provides a framework in which the potential sales tax revenue losses of state governments due to increasing e-commerce sales can be explored. Concerns over these revenue losses may, indeed, be justified. Conventional regions see both lower tax bases and tax rates when the Internet region competes. This necessarily leads to lower tax revenues for conventional regions with sustained e-commerce than before. The model concentrates on the case where the Internet firm chooses tax rates endogenously. Since currently Internet purchases are not taxed, this is equivalent to the case in which the Internet tax is zero.

understanding of the model's sensitivity to that assumption.

The strategic variable used in this model is the tax rate. An alternate for-

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Figure 1: One-Income Model with Three Regions

Figure 2: Conventional Tax Rates With and Without E-Commerce

Figure 2: Computational Tax Bases With and Without E-Commerce

Figure 5: Two-Income Model with Three Regions

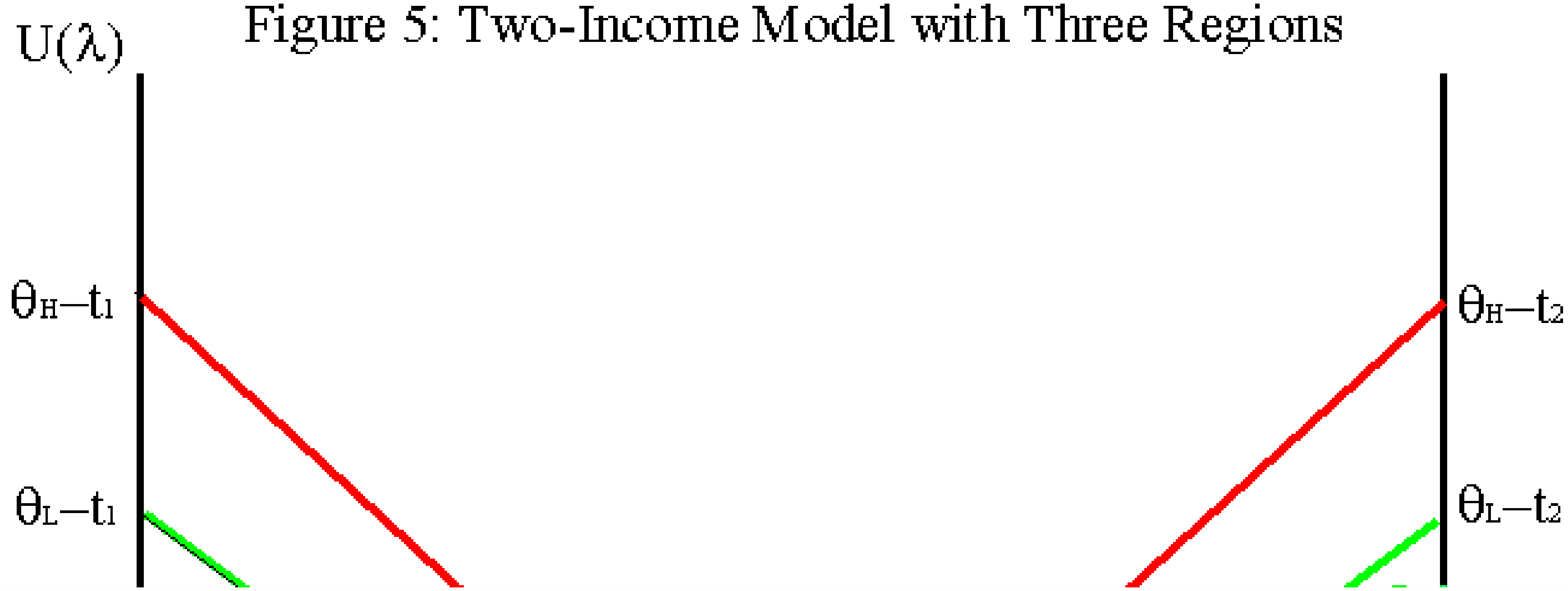

Figure 6: Tax Rates as a Function of the Fixed Cost of Shopping Online

Figure 7: Reaction Functions in Two-Issue Models

Figure 8: Deviation into Regime B for Region 1

Appendix

A Existence of Nash Equilibrium

In order for this Nash equilibrium to exist, certain conditions must hold for the exogenous parameters. Speci cally, all equilibrium tax rates must be non-negative, all s must be positive and ordered correctly, all graphical intercepts must be as pictured in gure 5, and some consumers must shop online.

(i) All tax rates non-negative: $t_1 \geq 0 \Longrightarrow$ ^{P}

B Deviation for Region 1 - Regime \B"

Superscript \A" is used to denote the original candidate Nash equilibrium values. The rst possible deviation for region 1 involves lowering t_1 su ciently as to capture the low-income online shoppers.

See gure 8 for a graphical interpretation of the shift into regime \B". Lowering t_1 corresponds to shifting out the utility curves of both the low- and high-income individuals. Region 1 can lower t_1 to a point where they capture all of the low-income online shoppers - shown by the point on the graph. For any tax rates lower than this (pushing out further the t_1 line) the tax base for region 1 is the following: $R_1^B : 0 \rightarrow \ _L$ and $0 \rightarrow \_{H}$.

Note that this is di erent than the original tax base, which was given by: $R_1^A : 0 \rightarrow \_{L}$ and $0 \rightarrow$ L

The tax rate such that region 1 shifts into regime B occurs is denoted

L

t_3^A , where t_3^A refers to the candidate Nash equilibrium value of t_3 described originally.

$\bar{t}_3 < t_3^A$ when $0 < \frac{P}{3\ S} + \frac{T}{3}$, which will always be the case because the right-hand side is always positive.

Revenue in regime D can be written as

$$R_3^D = t_3 \int_0^1 f(\ _L)d\ _L + t_3 \int_0^1 f(\ _H)d\ _H \qquad (32)$$

where $f(\ _L) = f(\ _H) = 1$.

This simpli es to $R_3^D = 2t_3$, and since $\frac{@R_3^D}{@t_3} = 2$, $\bar{t}_3$ will be the local maximum for regime D. Knowing the revenue function is continuous and strictly concave, t_3^A is the global maximum for R_3.

It is easy to check to see if $R_3^A(t_3^A\ ) > R_3^D(\bar{t}_3)$: $R_3^A(t_3^A\ ) = \frac{2}{9}\frac{(2\ P\ \ S T)^2}{P\ S}$

results must obey $k \neq 2$ and $3k - 2 \neq 0$. $k > 2$ guarantees that all of these conditions hold and that the social welfare maximizing reaction lie everywhere below those from the revenue maximization problem.