Tax Competition and Spatial Competition: The Effect of Falling Transport Costs and Electronic Commerce

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Abstract

We study the effect of the growth in electronic commerce on retail sales taxes using the logit model of product differentiation. Competing jurisdictions choose tax rates on retail businesses in their own jurisdictions and then firms choose prices. We solve numerically for the subgame perfect Nash equilibria of these games.

We consider two different tax structures, which differ in the treatment of sales by businesses in one jurisdiction to consumers in another jurisdiction. The first assumes complete evasion of use taxes (consumers who buy outside their home jurisdiction escape all sales taxes), which is close to the status quo in the U.S. The second assumes zero use tax evasion, which is close to the status quo in the EU.

We find that both tax rates and tax revenue fall sharply in a switch from zero to full use tax evasion. The effect is greater for lower costs of cross-border shopping. We also discuss some differences in comparative statics between the two tax regimes.

1. Introduction

State and local governments in the U.S. collect a significant fraction of their total tax revenue through retail sales taxes. This tax base faces threats of erosion from several sources: declines in the share of sales of taxable goods in national income; the growing importance of mail-order sales; and the recent development of electronic commerce. The first of these causes has led some states to attempt to expand sales taxes from goods to services. The latter two sources of erosion have a similar cause—changes in technology—shipping goods directly to consumers has become less costly due to declines in transportation costs, and possibly more importantly, declines in handling and processing costs.

State governments which levy sales taxes also levy use taxes, so that residents of the jurisdiction are liable for an equivalent tax in their place of residence on goods purchased elsewhere. A 1967 Supreme Court decision and a later affirmation [*National Bellas Hess*, 386 U.S. 753, 1967; *Quill*, 504 U.S. 298, 1992] require that sellers have nexus in a jurisdiction in order for it to be responsible for collecting sales or use taxes for that jurisdiction.[1] Congress has repeatedly declined to overturn the Court's decision. As a result, the collection experience for use taxes is so abysmal that one can almost ignore them. The recent moratorium on Internet taxes extends this treatment of mail order sales to Internet sales by probiting new tax regulations specifically targeting Internet sales.

While mail-order sales to consumers have grown since the 1960s, few would assert that the favorable tax treatment is the only cause. Similarly, the tax treatment explains only some of the recent growth of electronic commerce [Goolsbee, 2000]. Rapid technological advances in logistics and falling transportation costs for quick delivery of small packages have also made mail-order or Internet shopping simpler and easier. The ability of mail-order firms to hold more varieties in inventory than conventional retailers has probably also contributed to growth of this sector.[2]

State and local government officials are rightly concerned about the future of the sales tax base unless they can require sellers to assist them in collecting use taxes. Many conventional ("bricks-and-mortar') retailers are also concerned about the tax disadvantage they face in competing with Internet retailers. In addition to use tax evasion, mail-order and Internet retailers are considerably more mobile and can seek out locations with lower overall business taxes. Declines in the costs to consumers of buying outside their residence jurisdictions increase the intensity of tax competition among jurisdictions. They also make the intensity of price competition among firms fiercer in many monopolistic competition models.

We model a two-stage game of tax competition. First, each jurisdiction simultaneously chooses its tax rate to maximize a composite objective function (including revenue, resident welfare, and profits of resident firms). These tax rates then influence demand and costs for retailers based in the different jurisdictions. Retailers simultaneously choose prices given the set of tax rates facing all active firms. We solve numerically for subgame-perfect Nash equilibria of this two-stage game under different tax regimes.

Section 2 discusses the tax issues and some previous literature. Section 3 presents the basic model. Section 4 describes the price equilibrium and Section 5 describes the tax equilibrium. Section 6 presents our main simulation results. Section 7 contains our conclusions and discusses goals for further research.

2. The Tax Issues

There are many models of interjurisdictional competition in public economics. The structure of local government finance in the U.S. led to an initial focus on property tax competition. The Tiebout model [1956] has been a common starting point to study residential property taxes. In choosing where to reside, households select a combination of property taxes and public goods. With a large number of local governments in a metropolitan labor market, jurisdictions offer both the appropriate level of services for their residents and provide these services efficiently. What generates efficient outcomes in the simpler forms of Tiebout model is the tight connection between paying taxes and receiving services. The efficiency holds when only residential land values are taxed. Since non-residential real estate and residential structures also face local property taxes, the property tax does have some distortionary effects.

For retail sales taxes, the link between paying taxes and receiving services breaks down. A jurisdiction with a low tax rate can attract shoppers from other jurisdictions without the burden of having to provide any government services to them.[3] Because of this, tax competition may lead to underprovision of public services since the perceived marginal cost of public funds may be quite high.

One issue we need to explore as part of this study is the incidence of differential sales taxes in oligopoly. There has been some previous work in this area. Braid [1987] studies the incidence of sales taxes in a spatial oligopoly. Consumers buy from the store with the lowest price plus transport cost. Braid examines the effect of a single jurisdiction with one or more stores raising its tax rate, but he does not examine the equilibrium tax rates for several jurisdictions. Trandel [1992] is another paper along similar lines. Other papers such as Braid [1993] and Trandel [1994] study equilibrium tax rates, but they confine themselves to models with a single store per district. A common feature in the literature is that there is complete market segmentation—each store's customers are a distinct segment of the market. Given that only some consumers shop via the Internet, it seems important to study models with imperfect customer segmentation.

There is another literature studying tax competition when firms use marginal cost pricing, including Kanbur and Keen [1993]. Given the importance of product differentiation in many mail-order product lines, it seems more appropriate to study price-setting firms even at the cost of more complexity.

Currently, only retail stores collect sales taxes for their jurisdictions. Mail-order and Internet retailers collect sales taxes only for shipments within the same jurisdictions. Growth in sales through other channels could lead jurisdictions to replace sales taxes with other types of taxes on producers and distributors. In effect, these new taxes would be taxes based on the origin principle (the tax rate in the seller's jurisdiction would apply to transactions).

For now, we focus on the effects of eliminating use tax evasion. We thus compare:

1) the current U.S. tax system with 100% use tax evasion, and
2) sales taxes based on the destination principle, which applies for intra-EU transactions.[4]

3. The Model

Since consumers in the same jurisdiction patronize stores in several jurisdictions and each store's customers may reside in many different jurisdictions, it seems useful to examine models with incomplete market segmentation. The most workable of these models is the logit model of product differentiation which is studied in detail in Anderson, de Palma, and Thisse [1992]. Heterogeneity among consumers in this model enables stores to have overlapping market areas even with perfect information about prices on the part of consumers. Such a model seems quite useful to study consumer behavior in shopping through different channels such as retail shops, mail order, and electronic commerce Web sites.

We model demand for an individual product or product group using a well-known model of discrete choice by consumers among differentiated products. Each consumer chooses among all available products, as well as an outside option (buying no variety of output in this particular industry). The total population of consumers is normalized to one, with γ living in jurisdiction 1 and $1 - \gamma$ living in jurisdiction 2. There are N_1 firms in jurisdiction 1 and N_2 firms in jurisdiction 2. We first study a tax system in which each jurisdiction levies an *ad valorem* sales tax, and there is 100% use tax evasion—no consumers pay sales tax (to either jurisdiction) on purchases outside their residence jurisdiction.[5]

We first write the demand for firm i as the sum of two components: from consumers in its "home" jurisdiction and from consumers in the "foreign" jurisdiction,

or: $D_i = \gamma H_i + (1 - \gamma)F_i$ where $H_i = \dfrac{\exp\left(\dfrac{-p_i(1+\tau_1)}{\mu}\right)}{\Delta_{i1}}$

$$\Delta_{i1} = \exp\left(\frac{-p_i(1+\tau_1)}{\mu}\right) + (N_1 - 1)\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right) + N_2\exp\left(\frac{-p_2-\delta}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)$$

$$F_i = \frac{\exp\left(\frac{-p_i-\delta}{\mu}\right)}{\Delta_{i2}}$$

and $$\Delta_{i2} = \exp\left(\frac{-p_i-\delta}{\mu}\right) + (N_1 - 1)\exp\left(\frac{-p_1-\delta}{\mu}\right) + N_2\exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right).$$

In words, $H_i(p_i, p_1, p_2)$ equals the probability that a consumer residing in jurisdiction 1 buys from firm i in jurisdiction 1 when firm i charges p_i, the remaining firms in jurisdiction 1 charge p_1, and all firms in jurisdiction 2 charge p_2. When the consumer buys from a store in her home jurisdiction, the after-tax price equals $p_i(1+\tau_1)$. When buying from a store in the other jurisdiction, the after-tax price equals p_2, but the consumer incurs an additional cost of δ in making a purchase outside the jurisdiction. In accord with some casual observation, we assume that firms are unable to discriminate in price between resident and non-resident consumers. In other words, firm i charges the same mill price p_i regardless of where her customers are located, so that the hassle cost of δ is paid by the consumer. New technology reduces δ and the comparative statics of changes in δ are a major focus of our work here.

Similarly, $F_i(p_i, p_1, p_2)$ equals the probability that a consumer residing in jurisdiction 2 buys from firm i in jurisdiction 1 when firm i charges p_i, the remaining firms in jurisdiction 1 charge p_1, and all firms in jurisdiction 2 charge p_2.

Finally, the term V_0 stands for the utility of the outside option, whereas μ is a scale parameter which reflects the responsiveness of a consumer to differences in the "observable utility" among the different options (including the outside one).

Let firm j be a representative firm in jurisdiction 2. Its demand equals:

$$D_j = \gamma F_j + (1 - \gamma) H_j \quad \text{where} \quad H_j = \frac{\exp\left(\frac{-p_j(1+\tau_2)}{\mu}\right)}{\Delta_{j2}}$$

$$\Delta_{j2} = N_1 \exp\left(\frac{-p_1 - \delta}{\mu}\right) + (N_2 - 1)\exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right) + \exp\left(\frac{-p_j(1+\tau_2)}{\mu}\right) + \exp\left(\frac{V_o}{\mu}\right)$$

$$F_j = \frac{\exp\left(\frac{-p_j - \delta}{\mu}\right)}{\Delta_{j1}} \quad \text{and}$$

$$\Delta_{j1} = N_1 \exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right) + (N_2 - 1)\exp\left(\frac{-p_2 - \delta}{\mu}\right) + \exp\left(\frac{-p_j - \delta}{\mu}\right) + \exp\left(\frac{V_o}{\mu}\right).$$

4. The Price Equilibrium

We consider only quasi-symmetric equilibria in which all firms in jurisdiction 1 charge the same price and all firms in jurisdiction 2 charge the same price. We write the demand facing a firm in jurisdiction 1 as a function of the triple (p_i, p_1, p_2) in order to distinguish between its own price and the price of its rivals in the same jurisdiction in order to derive the demand derivatives we need to find the Nash equilibrium in prices.

Since p_i and p_j are producer prices, the profit functions for the representative firms are:

$$\Pi_i(p_i, p_1, p_2) = (p_i - c)D_i(p_i, p_1, p_2)$$

and

$$\Pi_j(p_i, p_1, p_2) = (p_j - c)D_j(p_j, p_1, p_2),$$

where c is marginal cost (which we assume to be identical across all firms and for all types of sales). We ignore any fixed costs, since our analysis considers exogenous numbers of firms.

The first-order conditions for profit maximization are:

$$\frac{\partial \Pi_i}{\partial p_i} = D_i + (p_i - c)\ \frac{\partial D_i}{\partial p_i}\ = 0$$

and $$\frac{\partial \Pi_j}{\partial p_j} = D_j + (p_j - c)\ \frac{\partial D_j}{\partial p_j} = 0,$$

where the demand derivatives equal:

$$\frac{\partial D_i}{\partial p_i} = \gamma\left[\frac{\partial H_i}{\partial p_i}\right] + (1-\gamma)\left[\frac{\partial F_i}{\partial p_i}\right]$$

$$= \gamma\left[\frac{-(1+\tau_1)}{\mu} H_i + \frac{(1+\tau_1)}{\mu}(H_i)^2\right] + (1-\gamma)\left[-\frac{1}{\mu}F_i + \frac{1}{\mu}(F_i)^2\right]$$

and $$\frac{\partial D_j}{\partial p_j} = \gamma\frac{\partial F_j}{\partial p_j} + (1-\gamma)\frac{\partial H_j}{\partial p_j}$$

$$= \gamma\left[-\frac{(1+\tau_2)}{\mu} H_j + \frac{(1+\tau_2)}{\mu}(H_j)^2\right] + (1-\gamma)\left[-\frac{1}{\mu}F_j + \frac{1}{\mu}(F_j)^2\right].$$

With a single market, existence of a pure strategy Nash equilibrium in prices is guaranteed (see Anderson, de Palma, and Thisse 1992). Because the demand functions are the sum of two logits, their proof cannot be applied directly.[6] However, a quasi-symmetric equilibrium can be guaranteed to exist for the levels of tax rates we observe.

Proposition 1: If $\max\{\tau_1, \tau_2\} < \hat{\tau}$**,** $\min\{N_1, N_2\} \geq 2$, and $\mu > 0$**,** there exists a Nash equilibrium in prices in which all firms in each jurisdiction charge a single price.

Proof: See Appendix A.

Closed-form solutions for these equilibrium prices are unavailable, even with $N_1 = N_2$ and $\tau_1 = \tau_2$ (except with zero tax rates). While specific taxes are not a common way to assess sales taxes, it is instructive to consider them because an analytic solution is available in the symmetric case.

Proposition 2: Let $t_1 = t_2 = t$ be the specific sales tax assessed in both jurisdictions. For $N_1 = N_2 = N$, the equilibrium price charged by all firms is:

$$p^*(N, t, \delta) = c + \frac{\mu N}{\Gamma}$$

$$\text{where } \Gamma = \frac{N-1+N\exp(-\beta)}{\left(1+\exp(-\beta)\right)^2} + \frac{N-1+N\exp(\beta)}{\left(1+\exp(\beta)\right)^2} \text{ and } \beta = \frac{\delta - t}{\mu}.$$

An increase in δ or a decrease in t have the same effect on p^*, and $\frac{\partial p^*}{\partial \delta} > 0$ if $\delta > t$ (and < 0 if $\delta < t$).

Proof: Firm i in jurisdiction 1 has the demand curve:

$$X_i = \frac{\exp\left(\frac{-p_i - t_1}{\mu}\right)}{\exp\left(\frac{-p_i - t_1}{\mu}\right) + (N_1 - 1)\exp\left(\frac{-p_1 - t_1}{\mu}\right) + N_2 \exp\left(\frac{-p_2 - \delta}{\mu}\right)}$$

$$+ \frac{\exp\left(\frac{-p_i - \delta}{\mu}\right)}{\exp\left(\frac{-p_i - \delta}{\mu}\right) + (N_1 - 1)\exp\left(\frac{-p_1 - \delta}{\mu}\right) + N_2 \exp\left(\frac{-p_2 - t_2}{\mu}\right)} = \frac{1}{H} + \frac{1}{F}$$

$$\text{where} \quad H = 1 + (N_1 - 1)\exp\left(\frac{-p_1 + p_i}{\mu}\right) + N_2 \exp\left(\frac{-p_2 - \delta + p_i + t_1}{\mu}\right)$$

$$\text{and} \quad F = 1 + (N_1 - 1)\exp\left(\frac{-p_1 + p_i}{\mu}\right) + N_2 \exp\left(\frac{-p_2 - t_2 + p_i + \delta}{\mu}\right).$$

Profit for firm i equals $\Pi_i = (P_i - c)D_i$. To obtain firm i's best reply,

$$\frac{\partial \Pi_i}{\partial p_i} = X_i + (p_i - c)\frac{\partial X_i}{\partial p_i} = 0 \text{ or}$$

$$\frac{1}{H}+\frac{1}{F}+(p_i-c)\left(\frac{-1}{H^2}\left[\frac{(N_1-1)}{\mu}\exp\left(\frac{-p_1+p_i}{\mu}\right)+\frac{N_2}{\mu}\exp\left(\frac{-p_2-\delta+p_i+t_1}{\mu}\right)\right]\right.$$

$$\left.-\frac{1}{F^2}\left[\frac{(N_1-1)}{\mu}\exp\left(\frac{-p_1+p_i}{\mu}\right)+\frac{N_2}{\mu}\exp\left(\frac{-p_2-t_2+p_i+\delta}{\mu}\right)\right]\right)=0.$$

At the symmetric solution when $t_1 = t_2 = t$ and $N_1 = N_2 = N$, $p_i = p_1 = p_2 = p$:

$$\frac{1}{N\left(1+\exp\left(\frac{t-\delta}{\mu}\right)\right)}+\frac{1}{N\left(1+\exp\left(\frac{\delta-t}{\mu}\right)\right)}$$

$$-\frac{(p-c)}{\mu N^2}\left[\frac{N-1+N\exp\left(\frac{t-\delta}{\mu}\right)}{\left[1+\exp\left(\frac{t-\delta}{\mu}\right)\right]^2}+\frac{N-1+N\exp\left(\frac{\delta-t}{\mu}\right)}{\left[1+\exp\left(\frac{\delta-t}{\mu}\right)\right]^2}\right]=0$$

or $$\frac{(p-c)}{\mu N}=\frac{1}{\left[\frac{N-1+N\exp\left(\frac{t-\delta}{\mu}\right)}{\left[1+\exp\left(\frac{t-\delta}{\mu}\right)\right]^2}+\frac{N-1+N\exp\left(\frac{\delta-t}{\mu}\right)}{\left[1+\exp\left(\frac{\delta-t}{\mu}\right)\right]^2}\right]}=\frac{1}{\Gamma}$$

(τ_1, τ_2)

Let $\beta = \frac{\delta - t}{\mu}$; then $\Gamma = \frac{N-1+N\exp(-\beta)}{(1+\exp(-\beta))^2}+\frac{N-1+N\exp(\beta)}{(1+\exp(\beta))^2}$.

Differentiating p* with respect to β, we obtain $\frac{\partial p^*}{\partial \beta}=\frac{-\mu N}{\Gamma^2}\frac{\partial \Gamma}{\partial \beta}$. Since

$\frac{\partial \Gamma}{\partial \beta}=-2\exp(\beta)\left(\frac{\exp(\beta)-1}{[1+\exp(\beta)]^3}\right)$, $\frac{\partial p^*}{\partial \beta}$ has the same sign as $\exp(\beta) - 1$. Thus, $\frac{\partial p^*}{\partial \beta} > 0$ if $\delta > t$. **QED**

The reversal of the effect of a tax rate increase as $\delta > t$ changes sign may seem surprising. The intuition is straightforward. When $\delta > t$, a consumer buys more in his jurisdiction; on the other hand, when $\delta < t$ he buys more from the distant jurisdiction.

The analysis of the price equilibrium under *ad valorem* taxes requires simulation analysis because there do not exist closed-form solutions for equilibrium prices. Table 1 displays some illustrative simulation results for equilibrium prices under *ad valorem* taxes.

Under the *no-use-tax-evasion* regime (NUTE), symmetric increases in taxes find about one quarter to one-third of a tax increase being absorbed by the firms:

$$\frac{0.0167}{0.05(1.3253)} = 0.2502 \qquad \text{for } \mu = 0.3$$

and

$$\frac{0.0268}{0.05(1.5287)} = 0.3506 \qquad \text{for } \mu = 0.5.$$

Increases in δ result in only small changes to these absorption rates.[7] Asymmetric tax increases (moving from $\tau_1 = \tau_2 = 0.10$ to $\tau_1 = 0.15$ and $\tau_2 = 0.10$, for example) result in smaller price changes for firms in both jurisdictions, with the price change for the firms more directly affected being about 150% of the price change for the firms in the jurisdiction whose tax rate remains constant.

Under the *use-tax-evasion* regime (UTE), for symmetric 5% increases in tax rates, price changes absorb one-sixth to one-fifth of the tax. For asymmetric changes in tax rates, the directly affected firms absorb about the same fraction of the tax as under NUTE, but the firms in the jurisdiction with unchanged tax rates change price hardly at all. More importantly, these firms may raise or lower price when rival firms in the other jurisdiction face a tax increase.

5. The Tax Equilibrium

We take a flexible approach to the question of each jurisdiction's objective function and assume that it consist of several items. For simplicity, we restrict ourselves to weighted sums of these factors as the objectives. The components are:

1) tax revenue

2) consumer surplus

and 3) profits.

Clearly, tax revenue matters for two reasons: financing purchases of public goods and services, and allowing reductions in other tax rates. Conventional optimal tax considerations would suggest that a local jurisdiction would prefer not to rely on a single tax base, but to tax as many different bases as possible at lower rates. Counting revenue and consumer surplus separately means effectively that we assume that consumers' utility is additively separable in public and private goods and also additively separable between the goods in the monopolistically competitive sector and all other goods (which are the outside option).

Local governments value the profitability of their resident firms for several reasons. Among them are revenues from taxes on business profits, incomes to local owners, and economic rents to local factors which depend on business profits.[8]

Formally, jurisdiction 1's tax revenue is $R_1 = \tau_1 p_1(\gamma N_1 H_i)$ since taxes are only collected on sales by resident firms to resident consumers.[9] Each jurisdiction only considers the surplus of its own residents in setting its *ad valorem* tax rate. From Anderson, de Palma, and Thisse [1992, p. 61], consumer surplus is:

$$S_1 = \mu \ln\left[\sum_1^n \exp\left(\frac{u_i}{\mu}\right)\right]$$

where u_i equals minus the full price of alternative i ($- p_1(1+\tau_1)$ or $-p_2 - \delta$).

Consumers in jurisdiction 1 choose among N_1 firms in jurisdiction 1 and N_2 firms in jurisdiction 2. Thus,

$$S_1 = \mu \ln\left[N_1 \exp\left(\frac{u_{11}}{\mu}\right) + N_2 \exp\left(\frac{u_{12}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]$$

where $u_{11} = -p_1(1+\tau_1)$ and $u_{12} = -p_2 - \delta$.

Similarly, $S_2 = \mu \ln\left[N_2 \exp\left(\frac{u_{22}}{\mu}\right) + N_1 \exp\left(\frac{u_{21}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]$

where $u_{22} = -p_2(1+\tau_2)$ and $u_{21} = -p_1 - \delta$

Since all firms within a jurisdiction charge the same equilibrium price, we have $p_i = p_1$ so that profit for a representative firm (denoted i) in jurisdiction 1 equals:

$$\Pi_i = (p_i - c)D_i(p_i, p_1, p_2; \tau_1, \tau_2)$$

$$= (p_i - c)\{\gamma H_i(p_i, p_1, p_2; \tau_1, \tau_2) + (1 - \gamma)F_i(p_i, p_1, p_2; \tau_1, \tau_2)\}$$

So total profits of firms producing in jurisdiction 1 are:

$$\Pi_1 = (p_i - c)N_1\{\gamma H_i(p_i, p_1, p_2; \tau_1, \tau_2) + (1 - \gamma)F_i(p_i, p_1, p_2; \tau_1, \tau_2)\}$$

and total profits of firms producing in jurisdiction 2 equals

$$\Pi_2 = (p_j - c)N_2\{\gamma F_j(p_j, p_1, p_2; \tau_1, \tau_2) + (1 - \gamma)H_j(p_j, p_1, p_2; \tau_1, \tau_2)\}.$$

In the subgame perfect equilibrium, jurisdiction 1 chooses τ_1 to maximize:

$$M_1 = a_1R_1 + a_2S_1 + a_3\Pi_1$$

and jurisdiction 2 chooses τ_2 to maximize:

$$M_2 = a_1R_2 + a_2S_2 + a_3\Pi_2$$

where a_1, a_2, a_3 ($\equiv 1 - a_1 - a_2$) are non-negative weights, and each jurisdiction takes account of the effects of tax rate changes on all equilibrium prices, $\frac{\partial p_1(\tau_1, \tau_2)}{\partial \tau_k}$ and $\frac{\partial p_2(\tau_1, \tau_2)}{\partial \tau_k}$, k = 1, 2.

The FOC for each jurisdiction are:

$$\frac{\partial M_1}{\partial \tau_1} = a_1 \frac{\partial R_1}{\partial \tau_1} + a_2 \frac{\partial S_1}{\partial \tau_1} + (1 - a_1 - a_2) \frac{\partial \Pi_1}{\partial \tau_1} = 0$$

$$\frac{\partial M_2}{\partial \tau_2} = a_1 \frac{\partial R_2}{\partial \tau_2} + a_2 \frac{\partial S_2}{\partial \tau_2} + (1 - a_1 - a_2) \frac{\partial \Pi_2}{\partial \tau_2} = 0.$$

Appendix B contains the formulas for these derivatives with respect to the tax rates.

6. Simulation Results

For the simulations of the full equilibrium, we choose parameters values so the equilibrium outcomes under use tax evasion approximate current state sales tax rates and imply sensible values for other measures, such as price-cost margins and the fraction of consumers who buy the product.[10]

Our baseline simulations use the following parameter values: $\gamma = 0.5$ (equal populations in the two jurisdictions), $c_1 = c_2 = 1.0$, $N_1 = N_2 = 3$ (firms in each jurisdiction), $a_1 = 0.60$ (revenue), $a_2 = 0.3$ (consumer surplus), and $a_3 = 0.10$ (profits). Simulations when there are 5 firms in each jurisdiction were quite similar. Equilibrium outcomes are sensitive to the weights in the local government objective functions; we discuss some of these effects below.

The parameter μ indicates the value of differentiation and its primary effect is on producer prices. Values of 0.3 and 0.5 result in price-cost margins $\left(\frac{p_i - c_i}{p_i}\right)$ of approximately 25-35%.[11] The value of the outside option V_0 has the most direct effect on total industry sales; our results focus on 60-80% of consumers buying some variety of the product. The hassle cost of cross-border shopping varies from 0.2 to 0.8; this parameter primarily influences the ratio of home to foreign sales.

Before discussing the tax-and-price equilibrium, it is useful to examine the best-reply functions for the jurisdictions in choosing tax rates. Table 2 presents some basic results. Several things stand out. First, the best replies are quite flat with less than a 2.5 percentage point change in tax rates as the exogenous tax rate moves from 5% to 15%. Second, under UTE, tax rates fall as the competing tax rate rises. In contrast under NUTE, best replies slope up.[12] Third, UTE best replies lie below NUTE best replies.[13] Fourth, increases in μ (the taste for variety) shift the best replies up and the effect is somewhat greater under NUTE. Lastly, decreases in δ shift the best replies down; this effect is greater under UTE.

Table 3 presents several sets of simulation results. Our baseline set appear in panel A. First, we confirm our intuition that use tax evasion results in lower equilibrium tax revenue. Note that this occurs for two reasons—some sales escape taxation, and equilibrium tax rates are lower. Profits are higher under UTE.

Tax rates rise as the value of the outside option falls (as the total demand curve for all varieties shift out). This effect is considerably more pronounced under NUTE than under UTE. With total sales near 80% of consumers, tax rates are approximately the level of EU standard VAT rates. Tax rates under UTE are somewhat higher than typical state plus local sales tax rates in the U.S.[14]

One difference in qualitative comparative statics is that producer prices move in opposite directions as V_0 changes under the two tax regimes. The differential magnitude of the tax rate changes is most likely a cause. Note that prices change only slightly with the changes in V_0; as with zero or one endogenous tax rate, the largest impact on prices comes from changes in μ, the variety parameter. A second distinction is that the ratio of home to foreign sales does not vary with tax rates and V_0 under NUTE due to the independence of irrelevant alternatives property of the logit, while the ration of home to foreign sales moves in the opposite direction of the tax rate under UTE.

Panel B of Table 3 displays results for different values of δ. A drop in δ increases demand directly by lowering the cost of some varieties at constant prices and taxes, and it also makes the market more competitive by making goods from firms in the other jurisdiction closer substitutes effectively.

As the cost of cross-border shopping falls from 80% to 20% of the good's production cost, equilibrium tax rates and revenue fall, but the effect is greater under UTE. As δ falls by 75%, revenue falls by only 15% under NUTE, while it falls by 72% under UTE.

As δ falls, jurisdictions face more pressure to lower tax rates under UTE. Under NUTE, this direct effect is not present, yet tax rates still fall with δ. Producer prices fall slightly, but the fall in consumer prices is greater, so sales and profits increase

Panel C of Table 3 displays the effect of changes in the taste for variety (μ). As discussed previously, the largest impact is one price-cost margins. Tax rates increase as

μ rises, as we should expect. As demand for individual firm's products becomes less elastic, the impact of taxes on sales falls in magnitude, which frees local governments to raise tax rates. The ratio of home to foreign sales falls considerably as μ rises because consumers resort to cross-border shopping to obtain a greater selection of varieties.

7. Further Research

A number of additional questions can be studied in this framework. First, how does the relative size of jurisdictions and the number of retailers in each affect equilibrium tax rates and revenues? Second, how do these taxes influence firms' location choices when jurisdictions are not identical? States with large populations may be affected much differently than states with small populations. Another issue to is compare these sales taxes to production-based taxes.

The answers to these additional questions will shed some light on future tax policy, including the role of sales taxes as electronic commerce grows. Since one alternative (at least within the U.S.) is to substitute a Federal sales tax for state and local taxes on Internet transactions, it will be instructive to see how far independently set tax rates fall from current levels as the effect of distance declines to low levels. We will also be able to study the effect of centrally-set uniform tax rates and alternative tax regimes on the competitiveness of electronic commerce.

[1] Activities such as advertising in newspapers published in a jurisdiction are not sufficient to establish nexus. The presence of manufacturing or retail sales establishments does establish nexus, so that mail-order firms may face several different tax issues in choosing the location of their facilities.

[2] The tax advantages of mail-order firms may have prevented the spread of modern logistical techniques to conventional retailers.

[3] California does not have local retail sales taxes per se, but a portion of the state sales tax is distributed to the jurisdiction where the sale occurred. Lewis and Barbour [1999] demonstrate that land-use decisions by local governments are affected by this tax, in that local governments appear to value the presence of retail businesses over other types of employment (and over residential uses).

[4] The Harmonized Sales Tax (HST) levied in the Canadian provinces of Newfoundland, New Brunswick, and Nova Scotia which use the same base as the federal GST (Goods and Services Tax) is another example of destination-based sales taxes. The system in other Canadian provinces is the same as that in the U.S. for inter-provincial transactions, but both the federal GST and the provincial tax is collected on shipments from outside Canada by Canada Customs and Revenue. For shipments to Saskatchewan, only GST is collected.

[5] See the Appendix for the demand functions without use tax evasion.

[6] In particular, the sum of two log-concave demand functions is not necessarily log-concave.

[7] For comparison, in a symmetric homogeneous product Cournot model with an *ad valorem* tax , the producer price falls at a rate less than 1/(number of firms + 2). Thus firms in our model absorb more of the tax.

[8] In some earlier simulation, we also had local output in the objective functions as a proxy for employment. It is clear from public debates that employment often weighs heavily for policymakers in regional development issues.

[9] Under NUTE, jurisdiction 1's tax revenue is $R_1 = \tau_1[p_1(\gamma N_1 H_i) + p_2(\gamma N_2 F_j)]$.

[10] Obviously, the fraction of consumers who buy any variety will vary considerably across product class. We focus below on the ranges that yield plausible tax rates and discuss the sensitivity to this factor.

[11] As a benchmark, traditional book retailers charge a 40% margin over the wholesale price. Since some additional costs are certainly part of long-run variable cost, we consider lower margins to be more indicative of conditions in the industry.

[12] With more weight on consumer surplus and less on profit (a_1 = 0.60, a_2 = 0.3, and a_3 = 0.10), the best replies slope down for some parameter values.

[13] With more weight on consumer surplus and less on profit (a_1 = 0.60, a_2 = 0.3, and a_3 = 0.10), NUTE best replies are below the UTE best replies for some parameter values.

[14] As of June 1995, state plus local general sales tax rates were between 8% and 9% in some cities in the following states: AL, CA, IL, LA, NY, OK, TN, TX, and WA. (Source, Advisory Commission on Intergovernmental Relations, *Significant Features of Fiscal Federalism 1995*, Table 28, available at http://www.library.unt.edu/gpo/acir/acir.html).

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Appendix A

Proof of Proposition 1: Consider a representative firm in jurisdiction 1 with the profit function $\Pi_i(p_i, p_1, p_2) = (p_i - c)D_i(p_i, p_1, p_2)$. We will show that $\Pi_i(p_i, p_1, p_2)$ is quasi-concave in p_i for p_1 and p_2 in a neighborhood around the equilibrium at which all firms in the same jurisdiction charge the same price. Thus, Π_i is single-peaked when all other prices equal their equilibrium values, so there exists a quasi-symmetric equilibrium.

We first prove that Π_i is concave on a restricted domain and then show that, outside the domain, Π_i is strictly smaller than its value on the border of the domain. The second derivative of Π_i with respect to p_i is:

$$\frac{\partial^2 \Pi_i}{\partial p_i^{\,2}} = 2\frac{\partial D_i}{\partial p_i} + (p_i - c)\,\frac{\partial^2 D_i}{\partial p_i^{\,2}}.$$

It will be simpler to split this expression into two pieces, using H_i and F_i. Thus, we write:

$$\frac{\partial^2 \Pi_i}{\partial p_i^{\,2}} = \gamma\left[2\frac{\partial H_i}{\partial p_i} + (p_i - c)\,\frac{\partial^2 H_i}{\partial p_i^{\,2}}\right] + (1-\gamma)\left[2\frac{\partial F_i}{\partial p_i} + (p_i - c)\,\frac{\partial^2 F_i}{\partial p_i^{\,2}}\right].$$

Rewrite $H_i = \dfrac{Z}{Z+W}$ where $Z \equiv \exp\left(\dfrac{-p_i(1+\tau_1)}{\mu}\right)$ and

$$W \equiv (N_1 - 1)\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right) + N_2\exp\left(\frac{-p_2-\delta}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right),$$

and $F_i = \dfrac{Y}{Y+V}$ where $Y \equiv \exp\left(\dfrac{-p_i-\delta}{\mu}\right)$ and

$$V \equiv (N_1 - 1)\exp\left(\frac{-p_1-\delta}{\mu}\right) + N_2\exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right).$$

First, $2\frac{\partial H_i}{\partial p_i}+(p_i - c)\ \frac{\partial^2 H_i}{\partial {p_i}^2}=\frac{(1+\tau_1)WZ}{\mu^2(Z+W)^2}\left[-2+\frac{(p_i-c)(1+\tau_1)(W-Z)}{\mu(Z+W)}\right]$. The term in brackets equals $-2+\frac{(p_i-c)(1+\tau_1)}{\mu}[1-2H_i]$, which is strictly negative for $p_i < c+\frac{2\mu}{1+\tau_1}$. Second, $2\frac{\partial F_i}{\partial p_i}+(p_i - c)\ \frac{\partial^2 F_i}{\partial {p_i}^2}=\frac{YV}{\mu^2(Y+V)^2}\left[-2+\frac{(p_i-c)(V-Y)}{\mu(Y+V)}\right]$. The term in brackets equals $-2+\frac{(p_i-c)}{\mu}[1-2F_i]$, which is strictly negative for $p_i < c + 2\mu$. Since the sum of two concave functions in concave, Π_i is concave on the smaller of these two domains, which is given by $p_i < c+\frac{2\mu}{1+\tau_1}$.

For $p_i \geq c+\frac{2\mu}{1+\tau_1}$, we can examine $\frac{\partial \Pi_i}{\partial p_i} = D_i + (p_i - c)\ \frac{\partial D_i}{\partial p_i} =$ $\gamma\left[H_i+(p_i-c)\frac{\partial H_i}{\partial p_i}\right]+(1-\gamma)\left[F_i+(p_i-c)\frac{\partial F_i}{\partial p_i}\right]$. Now, $H_i+(p_i-c)\frac{\partial H_i}{\partial p_i}=$ $\frac{Z}{Z+W}\left[1-\frac{(p_i-c)(1+\tau_1)}{\mu}(1-H_i)\right]$. For $p_i \geq c+\frac{2\mu}{1+\tau_1}$, the term in brackets is less than or equal to $-1 + 2H_i$. Similarly, $F_i+(p_i-c)\frac{\partial F_i}{\partial p_i}=\frac{Y}{Y+V}\left[1-\frac{(p_i-c)}{\mu}(1-F_i)\right]$. For $p_i \geq c+\frac{2\mu}{1+\tau_1}$, the term in brackets is less than or equal to $\frac{\tau_1-1+2F_i}{1+\tau_1}$.

The symmetric solution to the FOC yields a value for p_1 and p_2 of approximately $c+\frac{\mu}{1+\tau_1} < c+\frac{2\mu}{1+\tau_1}$ (which is the upper bound for the region where Π_i is concave in p_i

for all p_1 and p_2). Thus, $p_i > p_1$ and $p_i > p_2$ when $p_i \geq c + \frac{2\mu}{1+\tau_1}$. Now, W > Z and V > Y for $N_1 \geq 2$ whenever $p_i > p_1$ (firm i charges a higher price than its rivals in the same jurisdiction), so H_i and F_i are both less than ½ when $p_i > p_1$. Hence, the term $-1 + 2H_i$ is negative for $p_i \geq c + \frac{2\mu}{1+\tau_1}$. Since F_i is strictly less than ½, the term $\frac{\tau_1 - 1 + 2F_i}{1+\tau_1}$ is also negative for $p_i \geq c + \frac{2\mu}{1+\tau_1}$ as long as the tax rate is less than a threshold value $\hat{\tau}$. In practice, this threshold can be quite high: for $\delta > \tau_2 p_2$, $F_i < 1/(N_1+N_2)$ when $p_i > p_1 = p_2$, so tax rates could be as high as 2/3 when $N_1 = N_2 = 3$ (as we use in our simulations). Thus, for $p_i \geq c + \frac{2\mu}{1+\tau_1}$, $\Pi_i(p_i, p_1, p_2)$ is decreasing in p_i.

Hence, Π_i is quasi-concave in p_i, so there exists a pure strategy Nash equilibrium in prices for $\min\{N_1, N_2\} \geq 2$ and $\max\{\tau_1, \tau_2\} < \hat{\tau}$. **QED**

Appendix B

Derivation of the Subgame Perfect Nash Equilibria

The timing of the game is that the jurisdictions choose their tax rates, and then the firms choose prices. Let τ_1 be the tax parameter chosen by jurisdiction 1 and τ_2 be the tax parameter chosen by jurisdiction 2. Let $V^1(p_1, p_2; \tau_1, \tau_2)$ and $V^2(p_1, p_2; \tau_1, \tau_2)$ be the two jurisdictions' objective functions.

From Section 4, the first-order conditions for profit maximization are:

$$\frac{\partial \Pi_i}{\partial p_i} = D_i + (p_i - c)\frac{\partial D_i}{\partial p_i} = 0 \quad \text{and} \quad \frac{\partial \Pi_j}{\partial p_j} = D_j + (p_j - c)\frac{\partial D_j}{\partial p_j} = 0. \qquad \textbf{(A1)}$$

The FOC for the lst stage game are:

$$\frac{\partial V^1}{\partial \tau_1} + \frac{\partial V^1}{\partial p_1}\frac{\partial p_1}{\partial \tau_1} + \frac{\partial V^1}{\partial p_2}\frac{\partial p_2}{\partial \tau_1} = 0$$

and $$\frac{\partial V^2}{\partial \tau_2} + \frac{\partial V^2}{\partial p_1}\frac{\partial p_1}{\partial \tau_2} + \frac{\partial V^2}{\partial p_2}\frac{\partial p_2}{\partial \tau_2} = 0$$

We find the terms $\frac{\partial p_i}{\partial \tau_j}$ by totally differentiating the price equilibrium subgame FOC *before* imposing the symmetry conditions $p_i = p_1$ and $p_j = p_2$. Totally differentiate **(A1)** w.r.t. p_i, p_j, p_1, p_2, τ_k (k = 1 or 2) to obtain:

$$\frac{\partial^2 \Pi_i}{\partial p_i^2} dp_i + \frac{\partial^2 \Pi_i}{\partial p_i \partial p_1} dp_1 + \frac{\partial^2 \Pi_i}{\partial p_i \partial p_j} dp_j + \frac{\partial^2 \Pi_i}{\partial p_i \partial p_2} dp_2 = -\frac{\partial^2 \Pi_i}{\partial p_i \partial \tau_k} d\tau_k$$

$$\frac{\partial^2 \Pi_j}{\partial p_j \partial p_i} dp_i + \frac{\partial^2 \Pi_j}{\partial p_j \partial p_1} dp_1 + \frac{\partial^2 \Pi_j}{\partial p_j^2} dp_j + \frac{\partial^2 \Pi_j}{\partial p_j \partial p_2} dp_2 = -\frac{\partial^2 \Pi_j}{\partial p_j \partial \tau_k} d\tau_k$$

Now we can impose symmetry within a jurisdiction to get the matrix equation:

$$\begin{bmatrix} \frac{\partial^2\Pi_i}{\partial p_i^2}+\frac{\partial^2\Pi_i}{\partial p_i\partial p_1} & \frac{\partial^2\Pi_i}{\partial p_i\partial p_j}+\frac{\partial^2\Pi_i}{\partial p_i\partial p_2} \\ \frac{\partial^2\Pi_j}{\partial p_j\partial p_i}+\frac{\partial^2\Pi_j}{\partial p_j\partial p_1} & \frac{\partial^2\Pi_j}{\partial p_j^2}+\frac{\partial^2\Pi_j}{\partial p_j\partial p_2} \end{bmatrix}\begin{pmatrix} dp_1 \\ dp_2 \end{pmatrix} = \begin{bmatrix} -\frac{\partial^2\Pi_i}{\partial p_i\partial\tau_k} \\ -\frac{\partial^2\Pi_j}{\partial p_j\partial\tau_k} \end{bmatrix} d\tau_k \qquad k=1,2$$

and use Cramer's Rule to get the needed comparative statics derivatives:

$$\frac{\partial p_1}{\partial\tau_1},\ \frac{\partial p_2}{\partial\tau_1},\ \frac{\partial p_1}{\partial\tau_2},\ \text{and}\ \frac{\partial p_2}{\partial\tau_2}.$$

Ordinarily, $\frac{\partial^2\Pi_i}{\partial p_i\partial p_j}$ and $\frac{\partial^2\Pi_j}{\partial p_j\partial p_i}$ are both identically zero, but that may not hold across all demand structures.

The second derivatives in the matrix equation (using the modular forms) are:[1]

$$\frac{\partial^2\Pi_i}{\partial p_i^2}=2\frac{\partial D_i}{\partial p_i}+(p_i-c)\frac{\partial^2 D_i}{\partial p_i^2}$$

$$\frac{\partial^2\Pi_i}{\partial p_i\partial p_1}=\frac{\partial D_i}{\partial p_1}+(p_i-c)\frac{\partial^2 D_i}{\partial p_i\partial p_1}$$

$$\frac{\partial^2\Pi_i}{\partial p_i\partial p_2}=\frac{\partial D_i}{\partial p_2}+(p_i-c)\frac{\partial^2 D_i}{\partial p_i\partial p_2}$$

$$\frac{\partial^2\Pi_j}{\partial p_j\partial p_1}=\frac{\partial D_j}{\partial p_1}+(p_j-c)\frac{\partial^2 D_j}{\partial p_j\partial p_1}$$

$$\frac{\partial^2\Pi_j}{\partial p_j^2}=2\frac{\partial D_j}{\partial p_j}+(p_j-c)\frac{\partial^2 D_j}{\partial p_j^2}$$

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[1] Note $\frac{\partial D_i}{\partial p_1}\neq\frac{\partial D_i}{\partial p_i}$ and $\frac{\partial^2 D_i}{\partial p_i^2}\neq\frac{\partial^2 D_i}{\partial p_i\partial p_1}$ despite the symmetry, because we need to evaluate the response to an independent deviation by firm i.

$$\frac{\partial^2 \Pi_j}{\partial p_j \partial p_2} = \frac{\partial D_j}{\partial p_2} + (p_j - c)\frac{\partial^2 D_j}{\partial p_j \partial p_2}$$

$$\frac{\partial^2 \Pi_i}{\partial p_i \partial \tau_k} = \frac{\partial D_i}{\partial \tau_k} + (p_i - c)\frac{\partial^2 D_i}{\partial p_i \partial \tau_k} \qquad k = 1, 2$$

and $$\frac{\partial^2 \Pi_j}{\partial p_j \partial \tau_k} = \frac{\partial D_j}{\partial \tau_k} + (p_j - c)\frac{\partial^2 D_j}{\partial p_j \partial \tau_k} \qquad k = 1, 2.$$

Derivatives of equilibrium prices

Rewrite the matrix equations for derivatives of the equilibrium prices as:

$$\begin{bmatrix} A_1 & A_2 \\ A_3 & A_4 \end{bmatrix}\begin{pmatrix} dp_1 \\ dp_2 \end{pmatrix} = \begin{bmatrix} B_{11} \\ B_{12} \end{bmatrix}\begin{pmatrix} d\tau_1 \\ d\tau_1 \end{pmatrix} + \begin{bmatrix} B_{21} \\ B_{22} \end{bmatrix}\begin{pmatrix} d\tau_2 \\ d\tau_2 \end{pmatrix}.$$

Using Cramer's Rule, we obtain:

$$\frac{dp_1}{d\tau_1} = \frac{B_{11}A_4 - B_{12}A_2}{A_1A_4 - A_2A_3} \qquad \frac{dp_2}{d\tau_1} = \frac{B_{12}A_1 - B_{11}A_3}{A_1A_4 - A_2A_3}$$

$$\frac{dp_1}{d\tau_2} = \frac{B_{21}A_4 - B_{22}A_2}{A_1A_4 - A_2A_3} \qquad \text{and} \qquad \frac{dp_2}{d\tau_2} = \frac{B_{22}A_1 - B_{21}A_3}{A_1A_4 - A_2A_3}.$$

Full Use Tax Evasion

The necessary demand derivatives for the solution of the two-stage game are:

$$\frac{\partial D_i}{\partial p_i} = \gamma\left[\frac{\partial H_i}{\partial p_i}\right] + (1-\gamma)\left[\frac{\partial F_i}{\partial p_i}\right]$$

$$\frac{\partial^2 D_i}{\partial p_i^2} = \gamma\left[-\frac{(1+\tau_1)}{\mu}\frac{\partial H_i}{\partial p_i} + \frac{2(1+\tau_1)}{\mu}H_i\frac{\partial H_i}{\partial p_i}\right] + (1-\gamma)\left[-\frac{1}{\mu}\frac{\partial F_i}{\partial p_i} + \frac{2}{\mu}F_i\frac{\partial F_i}{\partial p_i}\right]$$

$$\frac{\partial H_i}{\partial p_i} = -\frac{(1+\tau_1)}{\mu}H_i + \frac{(1+\tau_1)}{\mu}(H_i)^2$$

$$\frac{\partial F_i}{\partial p_i} = -\frac{1}{\mu}F_i + \frac{1}{\mu}(F_i)^2$$

$$\frac{\partial D_i}{\partial p_1} = \gamma\frac{\partial H_i}{\partial p_1} + \frac{(1-\gamma)\partial F_i}{\partial p_1}$$

$$\frac{\partial H_i}{\partial p_1} = \frac{H_i}{\Delta_{i1}}(N_1 - 1)\frac{(1+\tau_1)}{\mu}\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right)$$

$$\frac{\partial F_i}{\partial p_1} = \frac{F_i}{\Delta_{i2}}\frac{(N_1 - 1)}{\mu}\exp\left(\frac{-p_1-\delta}{\mu}\right)$$

$$\frac{\partial^2 D_i}{\partial p_i \partial p_1} = \gamma\left[\frac{\partial^2 H_i}{\partial p_i \partial p_1}\right] + (1-\gamma)\left[\frac{\partial^2 F_i}{\partial p_i \partial p_1}\right]$$

$$\frac{\partial^2 H_i}{\partial p_i \partial p_1} = \frac{-(1+\tau_1)}{\mu}\frac{\partial H_i}{\partial p_1} + \frac{2(1+\tau_1)}{\mu}H_i\frac{\partial H_i}{\partial p_1}$$

$$\frac{\partial^2 F_i}{\partial p_i \partial p_1} = -\frac{1}{\mu}\frac{\partial F_i}{\partial p_1} + \frac{2}{\mu}F_i\frac{\partial F_i}{\partial p_1}$$

$$\frac{\partial D_i}{\partial p_2} = \gamma\frac{\partial H_i}{\partial p_2} + (1-\gamma)\frac{\partial F_i}{\partial p_2}$$

$$\frac{\partial H_i}{\partial p_2} = \frac{H_i}{\Delta_{i1}}\frac{N_2}{\mu}\exp\left(\frac{-p_2-\delta}{\mu}\right)$$

$$\frac{\partial F_i}{\partial p_2} = \frac{F_i}{\Delta_{i2}} \frac{N_2(1+\tau_2)}{\mu} \exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right)$$

$$\frac{\partial^2 D_i}{\partial p_i \partial p_2} = \gamma\left[-\frac{(1+\tau_1)}{\mu}\frac{\partial H_i}{\partial p_2} + \frac{2(1+\tau_1)}{\mu} H_i \frac{\partial H_i}{\partial p_2}\right] + (1-\gamma)\left[-\frac{1}{\mu}\frac{\partial F_i}{\partial p_2} + \frac{2}{\mu} F_i \frac{\partial F_i}{\partial p_2}\right]$$

$$\frac{\partial D_i}{\partial \tau_2} = (1-\gamma)\frac{\partial F_i}{\partial \tau_2} = (1-\gamma)\left[\frac{N_2 p_2}{\mu}\frac{F_i}{\Delta_{i2}} \exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right)\right]$$

$$\frac{\partial D_i}{\partial \tau_1} = \gamma \frac{\partial H_i}{\partial \tau_1}$$

$$\frac{\partial H_i}{\partial \tau_1} = -\frac{p_i}{\mu} H_i - \frac{H_i}{\Delta_{i1}}\left[\frac{-p_i}{\mu}\exp\left(-p_i \frac{(1+\tau_1)}{\mu}\right) - \frac{(N_1-1)p_1}{\mu}\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right)\right]$$

$$= -\frac{p_i}{\mu} H_i + \frac{p_i}{\mu} H_i^2 + \frac{p_1(N_1-1)}{\mu}\frac{H_i}{\Delta_{i1}}\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right)$$

$$\frac{\partial^2 D_i}{\partial p_i \partial \tau_1} = \gamma\left[\frac{-(1+\tau_1)}{\mu}\frac{\partial H_i}{\partial \tau_1} + \frac{2(1+\tau_1)}{\mu} H_i \frac{\partial H_i}{\partial \tau_1} - \frac{H_i}{\mu} + \frac{H_i^2}{\mu}\right]$$

$$\frac{\partial^2 D_i}{\partial p_i \partial \tau_2} = (1-\gamma)\left[-\frac{1}{\mu}\frac{\partial F_i}{\partial \tau_2} + \frac{2}{\mu} F_i \frac{\partial F_i}{\partial \tau_2}\right]$$

The demand derivatives for the representative firm in jurisdiction 2 are similar.

No Use Tax Evasion

We can write the demand for firm i in jurisdiction 1 as the sum of two components, “home” and “foreign” demand, or:

$D_i = \gamma H_i + (1-\gamma)F_i$ where $H_i = \dfrac{\exp\left(\dfrac{-p_i(1+\tau_1)}{\mu}\right)}{\Delta_{i1}}$

$$\Delta_{i1} = \exp\left(\frac{-p_i(1+\tau_1)}{\mu}\right) + (N_1 - 1)\exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right)$$

$$+ N_2 \exp\left(\frac{-p_2(1+\tau_1)-\delta}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)$$

$$F_i = \frac{\exp\left(\frac{-p_i(1+\tau_2)-\delta}{\mu}\right)}{\Delta_{i2}}$$

and $$\Delta_{i2} = \exp\left(\frac{-p_i(1+\tau_2)-\delta}{\mu}\right) + (N_1 - 1)\left(\frac{-p_1(1+\tau_2)-\delta}{\mu}\right)$$

$$+ N_2 \exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right).$$

For the representative firm j in jurisdiction 2:

$$D_j = \gamma F_j + (1 - \gamma)H_j \qquad \text{where } H_j = \frac{\exp\left(\frac{-p_j(1+\tau_2)}{\mu}\right)}{\Delta_{j2}}$$

$$\Delta_{j2} = N_1 \exp\left(\frac{-p_1(1+\tau_2)-\delta}{\mu}\right) + (N_2 - 1)\exp\left(\frac{-p_2(1+\tau_2)}{\mu}\right)$$

$$+ \exp\left(\frac{-p_j(1+\tau_2)}{\mu}\right) + \exp\left(\frac{V_o}{\mu}\right)$$

$$F_j = \frac{\exp\left(\frac{-p_j(1+\tau_1)-\delta}{\mu}\right)}{\Delta_{j1}}$$

$$\Delta_{j1} = N_1 \exp\left(\frac{-p_1(1+\tau_1)}{\mu}\right) + (N_2 - 1)\exp\left(\frac{-p_2(1+\tau_1)-\delta}{\mu}\right)$$

$$+ \exp\left(\frac{-p_j(1+\tau_1)-\delta}{\mu}\right) + \exp\left(\frac{V_o}{\mu}\right).$$

We do not present the demand derivatives for firm j here, but the authors will supply them upon request.

The Jurisdictions' Objective Functions under Use Tax Evasion

Revenue

The revenue maximization problem for jurisdiction 1 is:

$$\max_{\tau_1} \; R_1 = \tau_1 N_1 p_i \gamma H_i(p_i, p_1, p_2\,; \tau_1)$$

with the first derivative:

$$\frac{1}{\gamma N_1}\frac{\partial R_1}{\partial \tau_1} = p_i H_i(p_i, p_1, p_2\,; \tau_1) + \tau_1 p_i \frac{\partial H_i}{\partial \tau_1} + [\tau_1 H_i\,(p_i, p_1, p_2\,; \tau_1) + \tau_1 p_i \frac{\partial H_i}{\partial p_i} +$$

$$\tau_1 p_i \frac{\partial H_i}{\partial p_1}]\frac{\partial p_1}{\partial \tau_1} + [\tau_1 p_1 \frac{\partial H_i}{\partial p_2}]\frac{\partial p_2}{\partial \tau_1}\,.$$

Note that $\frac{\partial H_i}{\partial p_i}$ is the effect on demand for firm i's product of a change in its own price, while $\frac{\partial H_i}{\partial p_1}$ is the effect on its demand of a change in the price charged by all its rivals in jurisdiction 1. Since $p_i = p_1$ in the subgame-perfect equilibrium, $\frac{\partial p_i}{\partial \tau_1} = \frac{\partial p_1}{\partial \tau_1}$.

Consumer Surplus

Consumers in jurisdiction 1 choose among N_1 firms in jurisdiction 1 and N_2 firms in jurisdiction 2. Thus,

$$S_1 = \mu \ln\left[N_1 \exp\left(\frac{u_{11}}{\mu}\right) + N_2 \exp\left(\frac{u_{12}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]$$

where $u_{11} = -p_1(1+\tau_1)$ and $u_{12} = -p_2-\delta$

Similarly, $S_2 = \mu \ln\left[N_2 \exp\left(\frac{u_{22}}{\mu}\right) + N_1 \exp\left(\frac{u_{21}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]$

where $u_{22} = -p_2(1+\tau_2)$ and $u_{21} = -p_1-\delta$.

Prices are the equilibrium prices: $p_1^*(\tau_1, \tau_2)$ and $p_2^*(\tau_1, \tau_2)$.

The derivatives of surplus with respect to own tax rates are:

$$\frac{\partial S_1}{\partial \tau_1} = \frac{\mu\left[\frac{N_1}{\mu}\exp\left(\frac{u_{11}}{\mu}\right)(-p_1-(1+\tau_1)\frac{\partial p_1}{\partial \tau_1}) + \frac{N_2}{\mu}\exp\left(\frac{u_{12}}{\mu}\right)(-\frac{\partial p_2}{\partial \tau_1})\right]}{\left[N_1 \exp\left(\frac{u_{11}}{\mu}\right) + N_2 \exp\left(\frac{u_{12}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]}$$

$$= \frac{\left[N_1\exp\left(\frac{u_{11}}{\mu}\right)(-p_1-(1+\tau_1)\frac{\partial p_1}{\partial \tau_1}) + N_2\exp\left(\frac{u_{12}}{\mu}\right)(-\frac{\partial p_2}{\partial \tau_1})\right]}{\left[N_1 \exp\left(\frac{u_{11}}{\mu}\right) + N_2 \exp\left(\frac{u_{12}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]}$$

and

$$\frac{\partial S_2}{\partial \tau_2} = \frac{\mu\left[\frac{N_2}{\mu}\exp\left(\frac{u_{22}}{\mu}\right)(-p_2-(1+\tau_2)\frac{\partial p_2}{\partial \tau_2}) + \frac{N_1}{\mu}\exp\left(\frac{u_{21}}{\mu}\right)(-\frac{\partial p_1}{\partial \tau_2})\right]}{\left[N_2 \exp\left(\frac{u_{22}}{\mu}\right) + N_1 \exp\left(\frac{u_{21}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]}$$

$$= \frac{\left[N_2\exp\left(\frac{u_{22}}{\mu}\right)(-p_2-(1+\tau_2)\frac{\partial p_2}{\partial \tau_2}) + N_1\exp\left(\frac{u_{21}}{\mu}\right)(-\frac{\partial p_1}{\partial \tau_2})\right]}{\left[N_2 \exp\left(\frac{u_{22}}{\mu}\right) + N_1 \exp\left(\frac{u_{21}}{\mu}\right) + \exp\left(\frac{V_0}{\mu}\right)\right]}.$$

Profits

Total profits of firms producing in jurisdiction 1 equals:

$$\Pi_1 = (p_i - c)N_1\{\gamma H_i(p_i, p_1, p_2; \tau_1, \tau_2) + (1-\gamma)F_i(p_i, p_1, p_2; \tau_1, \tau_2)\}$$

and total profits of firms producing in jurisdiction 2 equals:

$$\Pi_2 = (p_j - c)N_2\{\gamma F_j(p_j, p_1, p_2; \tau_1, \tau_2) + (1-\gamma)H_j(p_j, p_1, p_2; \tau_1, \tau_2)\}.$$

The derivatives of profits with respect to own tax rates are then:

$$\frac{1}{N_1}\frac{\partial \Pi_1}{\partial \tau_1} = \frac{\partial p_1}{\partial \tau_1}\left(\gamma H_i + (1-\gamma)F_i\right) + \gamma\left(p_i - c_1\right)\left(\left[\frac{\partial H_i}{\partial p_i} + \frac{\partial H_i}{\partial p_1}\right]\frac{\partial p_1}{\partial \tau_1} + \frac{\partial H_i}{\partial p_2}\frac{\partial p_2}{\partial \tau_1} + \frac{\partial H_i}{\partial \tau_1}\right)$$

$$+ \left(1-\gamma\right)\left(p_i - c_1\right)\left(\left[\frac{\partial F_i}{\partial p_i} + \frac{\partial F_i}{\partial p_1}\right]\frac{\partial p_1}{\partial \tau_1} + \frac{\partial F_i}{\partial p_2}\frac{\partial p_2}{\partial \tau_1}\right)$$

$$\frac{1}{N_2}\frac{\partial \Pi_2}{\partial \tau_2} = \frac{\partial p_2}{\partial \tau_2}\left(\gamma F_j + (1-\gamma)H_j\right) + \gamma\left(p_j - c_2\right)\left(\left[\frac{\partial F_j}{\partial p_j} + \frac{\partial F_j}{\partial p_2}\right]\frac{\partial p_2}{\partial \tau_2} + \frac{\partial F_j}{\partial p_1}\frac{\partial p_1}{\partial \tau_2}\right)$$

$$+ (1-\gamma)\left(p_j - c_2\right)\left(\left[\frac{\partial H_j}{\partial p_j} + \frac{\partial H_j}{\partial p_2}\right]\frac{\partial p_2}{\partial \tau_2} + \frac{\partial H_j}{\partial p_1}\frac{\partial p_1}{\partial \tau_2} + \frac{\partial H_j}{\partial \tau_2}\right)$$

Table 1

Equilibrium Prices for Different Tax Rates

No use tax evasion (NUTE)

p_1	p_2	τ_1	τ_2	μ	δ	V_0
1.3485	1.3536	0.05	0.00	0.3	0.2	-1.6
1.3420	1.3420	0.05	0.05	0.3	0.2	-1.6
1.3312	1.3360	0.10	0.05	0.3	0.2	-1.6
1.3253	1.3253	0.10	0.10	0.3	0.2	-1.6
1.3153	1.3198	0.15	0.10	0.3	0.2	-1.6
1.3100	1.3100	0.15	0.15	0.3	0.2	-1.6
1.3050	1.3006	0.15	0.20	0.3	0.2	-1.6
1.3806	1.3999	0.05	0.00	0.3	0.8	-1.6
1.3792	1.3792	0.05	0.05	0.3	0.8	-1.6
1.3601	1.3780	0.10	0.05	0.3	0.8	-1.6
1.3589	1.3589	0.10	0.10	0.3	0.8	-1.6
1.3412	1.3579	0.15	0.10	0.3	0.8	-1.6
1.3402	1.3402	0.15	0.15	0.3	0.8	-1.6
1.3393	1.3237	0.15	0.20	0.3	0.8	-1.6
1.5674	1.5725	0.05	0.00	0.5	0.2	-1.6
1.5555	1.5555	0.05	0.05	0.5	0.2	-1.6
1.5395	1.5443	0.10	0.05	0.5	0.2	-1.6
1.5287	1.5287	0.10	0.10	0.5	0.2	-1.6
1.5140	1.5185	0.15	0.10	0.5	0.2	-1.6
1.5041	1.5041	0.15	0.15	0.5	0.2	-1.6
1.4949	1.4907	0.15	0.20	0.5	0.2	-1.6
1.5882	1.6094	0.05	0.00	0.5	0.8	-1.6
1.5827	1.5827	0.05	0.05	0.5	0.8	-1.6
1.5583	1.5779	0.10	0.05	0.5	0.8	-1.6
1.5534	1.5534	0.10	0.10	0.5	0.8	-1.6
1.5309	1.5491	0.15	0.10	0.5	0.8	-1.6
1.5265	1.5265	0.15	0.15	0.5	0.8	-1.6
1.5226	1.5057	0.15	0.20	0.5	0.8	-1.6

Use Tax evasion (UTE)

p_1	p_2	τ_1	τ_2	μ	δ	V_0
1.3453	1.3601	0.05	0.00	0.3	0.2	-1.6
1.3458	1.3458	0.05	0.05	0.3	0.2	-1.6
1.3334	1.3468	0.10	0.05	0.3	0.2	-1.6
1.3350	1.3350	0.10	0.10	0.3	0.2	-1.6
1.3248	1.3369	0.15	0.10	0.3	0.2	-1.6
1.3273	1.3273	0.15	0.15	0.3	0.2	-1.6
1.3300	1.3193	0.15	0.20	0.3	0.2	-1.6
1.3790	1.3998	0.05	0.00	0.3	0.8	-1.6
1.3778	1.3778	0.05	0.05	0.3	0.8	-1.6
1.3577	1.3765	0.10	0.05	0.3	0.8	-1.6
1.3566	1.3566	0.10	0.10	0.3	0.8	-1.6
1.3384	1.3557	0.15	0.10	0.3	0.8	-1.6
1.3377	1.3377	0.15	0.15	0.3	0.8	-1.6
1.3370	1.3212	0.15	0.20	0.3	0.8	-1.6
1.5651	1.5852	0.05	0.00	0.5	0.2	-1.6
1.5661	1.5661	0.05	0.05	0.5	0.2	-1.6
1.5493	1.5673	0.10	0.05	0.5	0.2	-1.6
1.5511	1.5511	0.10	0.10	0.5	0.2	-1.6
1.5368	1.5530	0.15	0.10	0.5	0.2	-1.6
1.5393	1.5393	0.15	0.15	0.5	0.2	-1.6
1.5419	1.5274	0.15	0.20	0.5	0.2	-1.6
1.5856	1.6130	0.05	0.00	0.5	0.8	-1.6
1.5842	1.5842	0.05	0.05	0.5	0.8	-1.6
1.5583	1.5830	0.10	0.05	0.5	0.8	-1.6
1.5574	1.5574	0.10	0.10	0.5	0.8	-1.6
1.5344	1.5567	0.15	0.10	0.5	0.8	-1.6
1.5341	1.5341	0.15	0.15	0.5	0.8	-1.6
1.5339	1.5135	0.15	0.20	0.5	0.8	-1.6

Table 2

Best Replies in the Tax Game

No use tax evasion (NUTE)

p_1	p_2	τ_1 endo – genous	τ_2 fixed	μ	δ	V_0	$\Delta\tau_1$ *	Total sales
1.3217	1.3251	0.0775	0.05	0.3	0.2	-1.2		0.6942
1.3153	1.3130	0.0813	0.10	0.3	0.2	-1.2		0.6759
1.3095	1.3020	0.0854	0.15	0.3	0.2	-1.2	0.0079	0.6560
1.3188	1.3291	0.1613	0.05	0.3	0.2	-1.6		0.8750
1.3128	1.3184	0.1633	0.10	0.3	0.2	-1.6		0.8673
1.3070	1.3084	0.1654	0.15	0.3	0.2	-1.6	0.0042	0.8581
1.3233	1.3469	0.1149	0.05	0.3	0.8	-1.2		0.5863
1.3218	1.3276	0.1165	0.10	0.3	0.8	-1.2		0.5676
1.3206	1.3100	0.1179	0.15	0.3	0.8	-1.2	0.0030	0.5484
1.3240	1.3762	0.2068	0.05	0.3	0.8	-1.6		0.8032
1.3222	1.3569	0.2084	0.10	0.3	0.8	-1.6		0.7923
1.3206	1.3391	0.2099	0.15	0.3	0.8	-1.6	0.0031	0.7802
1.5158	1.5241	0.1280	0.05	0.5	0.2	-1.2		0.6680
1.5038	1.5072	0.1328	0.10	0.5	0.2	-1.2		0.6570
1.4927	1.4915	0.1376	0.15	0.5	0.2	-1.2	0.0096	0.6452
1.5118	1.5250	0.1960	0.05	0.5	0.2	-1.6		0.8002
1.5005	1.5092	0.1992	0.10	0.5	0.2	-1.6		0.7934
1.4900	1.4944	0.2025	0.15	0.5	0.2	-1.6	0.0065	0.7858
1.5126	1.5353	0.1359	0.05	0.5	0.5	-1.2		0.6177
1.5037	1.5140	0.1409	0.10	0.5	0.5	-1.2		0.6060
1.4955	1.4945	0.1458	0.15	0.5	0.5	-1.2	0.0099	0.5938
1.5102	1.5455	0.2005	0.05	0.5	0.5	-1.6		0.7620
1.5014	1.5249	0.2045	0.10	0.5	0.5	-1.6		0.7540
1.4932	1.5059	0.2086	0.15	0.5	0.5	-1.6	0.0082	0.7453

* $\Delta\tau_1 = \tau_1(.15) - \tau_1(.05)$

Use tax evasion (UTE)

p_1	p_2	τ_1	τ_2	μ	δ	V_0	$\Delta\tau_1$	Tsales
1.3360	1.3329	0.0386	0.05	0.3	0.2	-1.2		0.7189
1.3378	1.3209	0.0334	0.10	0.3	0.2	-1.2		0.7103
1.3396	1.3108	0.0285	0.15	0.3	0.2	-1.2	-0.0101	0.7015
1.3451	1.3459	0.0526	0.05	0.3	0.2	-1.6		0.9016
1.3481	1.3333	0.0446	0.10	0.3	0.2	-1.6		0.8980
1.3513	1.3221	0.0369	0.15	0.3	0.2	-1.6	-0.0157	0.8941
1.3243	1.3471	0.1112	0.05	0.3	0.8	-1.2		0.5945
1.3246	1.3280	0.1096	0.10	0.3	0.8	-1.2		0.5791
1.3248	1.3108	0.1081	0.15	0.3	0.8	-1.2	-0.0031	0.5634
1.3281	1.3745	0.1823	0.05	0.3	0.8	-1.6		0.8188
1.3287	1.3552	0.1785	0.10	0.3	0.8	-1.6		0.8108
1.3294	1.3374	0.1745	0.15	0.3	0.8	-1.6	-0.0078	0.8021
1.5490	1.5514	0.0566	0.05	0.5	0.2	-1.2		0.6933
1.5519	1.5351	0.0506	0.10	0.5	0.2	-1.2		0.6883
1.5548	1.5209	0.0449	0.15	0.5	0.2	-1.2	-0.0116	0.6831
1.5600	1.5665	0.0674	0.05	0.5	0.2	-1.6		0.8291
1.5641	1.5496	0.0593	0.10	0.5	0.2	-1.6		0.8259
1.5683	1.5345	0.0515	0.15	0.5	0.2	-1.6	-0.0160	0.8225
1.5137	1.5581	0.1467	0.05	0.5	0.8	-1.2		0.5908
1.5151	1.5339	0.1432	0.10	0.5	0.8	-1.2		0.5831
1.5165	1.5122	0.1397	0.15	0.5	0.8	-1.2	-0.0070	0.5753
1.5180	1.5811	0.1891	0.05	0.5	0.8	-1.6		0.7476
1.5203	1.5563	0.1832	0.10	0.5	0.8	-1.6		0.7423
1.5225	1.5339	0.1775	0.15	0.5	0.8	-1.6	-0.0116	0.7367

* $\Delta\tau_1 = \tau_1(.15) - \tau_1(.05)$

Table 3

The Tax Equilibrium

p_1	τ_1	μ	δ	V_0	Revenue	Profit per firm	Home/ foreign sales	Total sales
No use tax evasion (NUTE)								
1.3205	0.0990	0.3	0.5	-1.2	0.0397	0.0324	5.29	0.6069
1.3196	0.1383	0.3	0.5	-1.4	0.0654	0.0382	5.29	0.7174
1.3141	0.1878	0.3	0.5	-1.6	0.0990	0.0420	5.29	0.8025
1.4963	0.1454	0.5	0.5	-1.2	0.0647	0.0492	2.72	0.5949
1.4914	0.1767	0.5	0.5	-1.4	0.0881	0.0548	2.72	0.6686
1.4836	0.2139	0.5	0.5	-1.6	0.1163	0.0591	2.72	0.7330
Use tax evasion (UTE)								
1.3281	0.0828	0.3	0.5	-1.2	0.0274	0.0346	3.67	0.6332
1.3329	0.1027	0.3	0.5	-1.4	0.0398	0.0419	3.35	0.7552
1.3362	0.1195	0.3	0.5	-1.6	0.0513	0.0476	3.11	0.8487
1.5310	0.1016	0.5	0.5	-1.2	0.0326	0.0558	1.99	0.6300
1.5363	0.1127	0.5	0.5	-1.4	0.0405	0.0635	1.92	0.7107
1.5409	0.1226	0.5	0.5	-1.6	0.0480	0.0704	1.86	0.7805

Panel A

Changes in the Value of the Outside Option

p_1	τ_1	μ	δ	V_0	Revenue	Profit per firm	Home/ foreign sales	Total sales
No use tax evasion (NUTE)								
1.3139	0.1169	0.3	0.2	-1.4	0.0602	0.0410	1.95	0.7839
1.3196	0.1383	0.3	0.5	-1.4	0.0654	0.0382	5.29	0.7174
1.3222	0.1597	0.3	0.8	-1.4	0.0711	0.0361	14.39	0.6729
1.4889	0.1680	0.5	0.2	-1.4	0.0898	0.0585	1.49	0.7178
1.4914	0.1767	0.5	0.5	-1.4	0.0881	0.0548	2.72	0.6686
1.4898	0.2006	0.5	0.8	-1.4	0.0932	0.0509	4.95	0.6237
Use tax evasion (UTE)								
1.3413	0.0471	0.3	0.2	-1.4	0.0160	0.0471	1.58	0.8284
1.3329	0.1027	0.3	0.5	-1.4	0.0398	0.0419	3.35	0.7552
1.3282	0.1412	0.3	0.8	-1.4	0.0579	0.0381	7.70	0.6974
1.5558	0.0608	0.5	0.2	-1.4	0.0201	0.0710	1.23	0.7669
1.5363	0.1127	0.5	0.5	-1.4	0.0405	0.0635	1.92	0.7107
1.5202	0.1580	0.5	0.8	-1.4	0.0597	0.0572	3.06	0.6593

Panel B

Changes in the Hassle Cost

p_1	τ_1	μ	δ	V_0	Revenue	Profit per firm	Home/ foreign sales	Total sales
No use tax evasion (NUTE)								
1.3139	0.1169	0.3	0.2	-1.4	0.0602	0.0410	1.95	0.7839
1.4036	0.1411	0.4	0.2	-1.4	0.0737	0.0501	1.65	0.7443
1.4889	0.1680	0.5	0.2	-1.4	0.0898	0.0585	1.49	0.7178
1.3196	0.1383	0.3	0.5	-1.4	0.0654	0.0382	5.29	0.7174
1.4071	0.1556	0.4	0.5	-1.4	0.0752	0.0466	3.49	0.6868
1.4914	0.1767	0.5	0.5	-1.4	0.0881	0.0548	2.72	0.6686
Use tax evasion (UTE)								
1.3413	0.0471	0.3	0.2	-1.4	0.0160	0.0471	1.58	0.8284
1.4489	0.0532	0.4	0.2	-1.4	0.0176	0.0592	1.36	0.7916
1.5558	0.0608	0.5	0.2	-1.4	0.0201	0.0710	1.23	0.7669
1.3329	0.1027	0.3	0.5	-1.4	0.0398	0.0419	3.35	0.7552
1.4343	0.1070	0.4	0.5	-1.4	0.0393	0.0526	2.38	0.7272
1.5363	0.1127	0.5	0.5	-1.4	0.0405	0.0635	1.92	0.7107

Panel C

Changes in the Value of Diversity