Tax Competition and Tax Harmonization With Evasion

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Abstract

We examine a two-jurisdiction tax competition environment where local governments can only imperfectly monitor where agents pay taxes and risk-averse individuals may choose to cross borders to pay lower taxes in a neighboring location.

In a game between local authorities, we find that, when communities differ in size, in equilibrium the smaller community sets lower taxes and attracts agents from the larger jurisdiction. With identical communities, tax rates must be equal.

Finally, we examine the incentives of jurisdictions to harmonize tax rates and find that, whenever the smaller community benefits from tax harmonization, the larger jurisdiction will benefit also.

KEYWORDS: Tax Competition, Tax Evasion, Tax Harmonization, Risk Aversion

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1 Introduction

In this paper we examine an environment where local authorities compete to maximize revenues from residence-based personal taxation and where individuals have the ability to evade taxes via illegal cross-border shopping, i.e., individuals can choose in which community to pay their contributions by lying about their place of residence. Local governments can verify if individual agents have paid taxes, but can only imperfectly monitor if they do so in their community of residence.

We model the competition among jurisdictions that strategically account for the cross-border shopping decisions induced by tax differences across locations. In our framework we characterize the individual decision of whether to evade taxes under the assumption of risk aversion. Residents in each community are ordered in terms of risk aversion and therefore face different incentives towards tax evasion.

We examine the implications of size differences across communities on the relative tax rates set by rival locations. Previous studies find that small communities set lower taxes in equilibrium. We extend this result to the case of risk-averse agents in the context of tax evasion. In this environment, small locations generate revenues by attracting tax evaders from the large community, which more-than-compensates for revenues lost from the local tax base when it lowers tax rates.

We also examine the problem of policy coordination. For this, we analyze the conditions under which harmonization to a common tax policy benefits each location and their incentives to reach an agreement. We find that whenever the smaller community agrees to harmonize taxes, the larger one will also.

In the literature on tax competition, the advantages of small regions are characterized by Bucovetsky (1991) and Wilson (1991), who analyze the effects of jurisdiction size on the equilibrium tax rates in a representative agent environment. Hoyt (1992) describes the market power that large central cities have at setting property taxes relative to smaller suburban cities. In a spatial competition framework, Kanbur and Keen (1993) and Ohsawa (1999) examine which countries choose to become tax havens. They find that small regions set lower tax rates in the case of risk-neutral individuals. Neither of these approaches examine tax evasion.

Cremer and Gahvari (2000) is the only other study of evasion in a model of tax competition we are aware of that is close to ours. They examine economic integration of countries which have two different types of evasion behavior for their residents, and individuals may only evade taxes if the country’s type is “dishonest”. They analyze tax evasion within the countries in an economic union; their motivation is similar to ours, but in their framework agents are risk-neutral, as in Kanbur and Keen (1993).

We model evasion as the individual problem of choosing to pay taxes at home or facing a gamble of paying taxes in the low-tax community with the possibility of being caught. The intuition of treating tax evasion as a lottery was first developed by Allingham and Sandmo (1972) and has been widely used in the literature on income tax evasion.
Examples of illegal cross-border shopping to avoid taxes in the United States include the smuggling of alcohol and tobacco across state borders. Although the consumption of alcohol and tobacco is not illegal, in many instances shipping these goods across state borders is. Empirical studies suggest that cross-border shopping of alcohol and tobacco is a significant factor in explaining sales differentials among U.S. states; see for example Saba et al. (1995), Crawford and Tanner (1995), and Beard et al. (1997). This evidence suggests that cross-border shopping may hinder the ability of local and state governments to raise tax revenues. In fact, the popular press has recently remarked on the potential impact of online trade on the avoidance of state sales taxes in the United States. Furthermore, policymakers from several states have agreed to a proposal labelled “The Streamlined Sales Tax Project,” that essentially amounts to a nation-wide effort to coordinate the collection of online sales taxes.1

Another instance of cross-border shopping in the United States is the system of car registration fees. States require that every vehicle display a license plate in order to circulate, and since registration fees may differ across local or state governments, agents may illegally choose to register their car in a neighboring low-tax community (producing proof of residence in that community). It is easy to verify that a car owner has paid registration fees somewhere, but there is no easy way to check where motorists actually drive their cars, since local authorities do not know if a car with out-of-state plates has been in the state for one week or one year. There are, however, penalties for perpetrators who are caught.

Casual evidence suggests that this problem may be of some relevance. For example, the Minneapolis Star Tribune2 reports that “an estimated 35,000 Minnesotans have illegally registered their cars in neighboring states, mostly in Wisconsin, which has lower annual registration fees.” This represents, they say, a loss of approximately $3.5 million in the state’s highway trust fund, to which total registration fees contribute 47% (almost $450 million). License tabs for cars in Minnesota range from $35 to about $475, while Wisconsin has a flat fee of $45. If prosecuted, individuals face sentences of up to one year in jail and a $3,000 fine. The Boston Globe3 relates the case of Massachusetts and New Hampshire: insurance costs in Massachusetts are much higher than in New Hampshire, where auto insurance is not even required until the first accident occurs. The Boston Globe also relates the concern of the Insurance Fraud Bureau, which estimates the costs in lost insurance, taxes, and fees to the state at about $1,200 a year per unregistered car.

Comparing the pattern of registered cars in the United States with the number of cars people reported owning in the 1990 Census, some states appear to show an influx of cars from other states. Massachusetts, in particular, seems to be surrounded by receptor states. In fact, in a 1997 study, Robert Cerasoli, Inspector General of the Commonwealth of Massachusetts, expresses great concern about “motor vehicle owners who cheat their fel-

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1See <http://www.streamlinedsalestax.org/>.
Figure 1: Differences Between Owned and Registered Cars by State

low motorists by dodging the payment of taxes, fees and insurance premiums by illegally registering their vehicles out of state or out of town.”

The map in Figure 1 shows the number of registered cars by state compared with the number of cars owned by households in 1990.4

In South America, Uruguayan states are found to behave strategically when setting car registration fees. Statistical evidence suggests that differences in community sizes and income distribution are relevant in determining the outcomes. Montevideo, by far the largest community, has historically set higher fees than other municipalities. In 1995, traffic inspectors monitored the main street access to downtown Montevideo and found that 40% of the cars were from other communities. Maldonado, a small municipality, seems to have received an important share of tax evaders over the years. The different municipalities have signed cooperation agreements in setting registrations fees, but local governments have continued to compete with various discount schemes for tax payments. The only community that has rejected the agreements and has continued fixing lower fees is the smallest of all communities.

The outline of this paper is as follows: In section 2 we introduce the model, we analyze the agents’ decision problem, we state the game between the local governments, and we define an equilibrium concept. In section 3 we characterize the properties of pure strategy equilibria for identical and different communities. Then in section 4 we analyze the incentives of communities to harmonize tax rates and the benefits this may imply. Finally, we conclude in section 5.

4Registration data were obtained from Highway Statistics 1990 and are based on states’ registration records. The number of cars owned by households was obtained from the 1990 Census of Population and Housing. We computed the difference between these two series.
2 The Model

There are two communities, each populated by a continuum of agents who differ in levels of income, $y$, that is measured in units of a private consumption good. Income distribution in each community is defined on the support $[y, \bar{y}]$ and is characterized by a continuous density function $N_i \phi(y)$, where $\int_{y}^{\bar{y}} \phi(y) dy = 1$ and $N_i > 0$, for $i = 1, 2$, denotes the population size. We use $\Phi$ to denote the cumulative distribution function of the density $\phi$, and we let $\theta$ denote the populations ratio $N_1/N_2$.

We assume that individuals in each community are expected-utility maximizers and have identical preferences over net income. We assume that the Bernoulli utility function, $u$, representing preferences for money, satisfies $u' > 0$, $u'' < 0$, and decreasing absolute risk aversion: i.e., the Arrow-Pratt coefficient of absolute risk aversion, $-u''/u'$, is a decreasing function of income. Intuitively, this property implies that wealthier individuals will be less risk-averse. This assumption yields economically sensible results concerning risk-bearing behavior and has received substantial empirical support. The ordering in terms of income is not essential. Kanbur and Keen (1993), for example, examine a framework of risk-neutral individuals with identical income—or valuations—who face different transportation costs. In the risk-aversion context, we could, alternatively, consider a setting where individuals had identical incomes but were heterogeneous in their preferences for risk or a setting where they were heterogeneous in both dimensions.\(^5\)

Local governments fix residence-based head taxes, $T_i$, $i = 1, 2$. Local governments can verify if individuals contribute or not, but can only imperfectly verify if they do it where they are supposed to because agents may choose to declare residence in a neighboring community, if it requires a lower tax, and pay taxes there. Imperfect verification may arise, for example, because the low-tax jurisdiction would not have incentives to verify residency and report tax evaders from the high-tax community. Verifying residency at the time of tax payment may also be problematic. Confusion may arise if the local tax authority of the high-tax jurisdiction does not share residence information with jurisdictions in a different state or with other local government agencies where individuals might have declared residence, for example, in income tax returns or mortgage contracts.

We assume that local governments have access to an exogenous monitoring technology, represented by a constant audit probability, $\pi \in (0, 1)$. A random audit policy is, in general, a simplification that reflects the empirical observation that tax authorities only detect a fraction of evasion (see Feinstein 1991). Underlying this assumption are costs of auditing that limit the amount of verification that takes place.

If an individual decides to evade taxes he takes into account the local government’s monitoring efforts. The penalty for evasion is having to pay a constant fine, $F > 0$.\(^6\) To

\(^5\)These alternative specifications would yield similar results concerning the characterization of aggregate evasion as long as a monotone ordering of individuals in terms of a function of the heterogeneity parameters can be established. Rothstein (1990) examines a class of preferences satisfying this property.

\(^6\)In our framework evasion is a binary choice, therefore the same qualitative results can be obtained under alternative fine functions as long as the ordering of individuals in terms of risk aversion, and therefore
simplify the analysis of the tax competition game, we assume that fines are not choice variables. For simplicity, we also assume that fines and audit probabilities are the same across locations, but this is not essential for the results.

Finally, in our setting local governments maximize revenues per capita. Resources are generated from residents who comply with taxation and from fines of perpetrators that are caught. This assumption is more realistic than the extreme Leviathan assumption where local governments maximize total revenues. Intuitively, we can think that local governments are concerned about the per-person cost of public programs. We follow Kanbur and Keen (1993) and view this modeling strategy as justified in an environment where consumers have a very high marginal valuation of some public good which is financed with tax revenues.

The model describes competition for fiscal revenue by means of a non-cooperative game where the local governments take into account their residents’ tax evasion decisions, but where individuals in both communities take tax policies as given and do not engage in strategic considerations. The evasion decisions are determined next.

### 2.1 The Decision Problem of Individuals

Given announced policies in both communities \((T_1, T_2)\), individuals have to decide whether to pay taxes at home or lie about their place of residence and pay taxes in the rival location. A resident in community 1 with income \(y\) derives certain utility \(u(y - T_1)\) if he decides to pay at home. If he lies, his expected utility is \((1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)\).

**Remark 1** A necessary condition for tax evasion in community 1 is \(T_2 < T_1\). A sufficient condition is \(T_2 + F \leq T_1\).

Clearly, the interesting case to discuss is when \(T_2 < T_1 < T_2 + F\), since we may have \(u(y - T_1) \leq (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)\). The following two propositions refer to this case.

**Proposition 1** For any configuration of taxes \((T_1, T_2)\), and for each community \(i\), there exists a unique cut-off income level, \(y_i^* \in [y, \bar{y}]\), such that every agent in community \(i\) with \(y > y_i^*\) decides to evade, and those with \(y < y_i^*\) decide not to.

**Proof.** Examine the problem of an agent in community 1. For any \(y \in [y, \bar{y}]\), define \(c(y, T_2)\) to be the certainty equivalent of the evasion lottery, i.e., the level of net income such that \(u(c(y, T_2)) = (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)\). An agent with income \(y\) will not evade if and only if \(u(y - T_1) > (1 - \pi)u(y - T_2) + \pi u(y - T_2 - F)\); by the definition of \(c(y, T_2)\), this is equivalent to requiring that \(y - c(y, T_2) > T_1\). Since \(u\)
evasion choices, is preserved. This differs from standard models of income-tax evasion where individuals have to choose how much income to under-report. For example, we could assume that fines are a linear function of the home tax rate to include situations where, in addition to being penalized with a fine, the evaded tax is always paid, \(F_i = \alpha + \beta T_i\).
satisfies decreasing absolute risk aversion, \( y - c(y, T_2) \) is strictly decreasing in \( y \), and, therefore, \( \bar{y} \) such that \( \bar{y} - c(\bar{y}, T_2) = T_1 \) is unique when it exists. Define \( y^*_1 \) by:

\[
y^*_1 = \begin{cases} 
  y & \text{if } y - c(y, T_2) \leq T_1 \\
  \bar{y} & \text{if } \bar{y} - c(\bar{y}, T_2) \geq T_1 \\
  \bar{y} & \text{if } y - c(y, T_2) > T_1 \text{ and } \bar{y} - c(\bar{y}, T_2) < T_1.
\end{cases}
\]

Thus \( y^*_1 \) is unique and satisfies the required properties; \( y^*_2 \) is defined analogously. \( \blacksquare \)

There are three cases shown in Figure 2. In case B there is no tax evasion, in case C everybody evades, and in case A only the rich do. The individual with income level \( y = y^*_1 \) is indifferent. If \( y^*_1 = \bar{y} \), there is no tax evasion. According to this proposition, if in equilibrium there is any tax evasion in a community, it is the rich agents who evade.8

Figure 2: Evasion Decisions

The cut-off income level, \( y^*_1 \), satisfies the following:

**Proposition 2** \( y^*_1 \) is non-increasing in \( T_1 \) and non-decreasing in \( T_2 \).

**Proof.** It is enough to prove the result for an interior \( y^*_1 \in (y, \bar{y}) \). In this case, the implicit function theorem implies that \( y^*_1 \) is continuous and differentiable, and we have that evasion increases with the home tax rate:

\[
\frac{\partial y^*_1}{\partial T_1} = \frac{u'(y^*_1 - T_1)}{u'(y^*_1 - T_1) - (1 - \pi)u'(y^*_1 - T_2) - \pi u'(y^*_1 - T_2 - F)} < 0.
\]

The sign follows because the numerator is positive and the denominator is negative by lemma 1 in the appendix. Similarly, evasion decreases with the foreign tax rate:

\[
\frac{\partial y^*_1}{\partial T_2} = \frac{-(1 - \pi)u'(y^*_1 - T_2) - \pi u'(y^*_1 - T_2 - F)}{u'(y^*_1 - T_1) - (1 - \pi)u'(y^*_1 - T_2) - \pi u'(y^*_1 - T_2 - F)} > 0.
\]

Given that \( u' > 0 \), by the inverse function theorem, \( u^{-1} \) exists and is differentiable, thus \( c(y, T_2) \) is continuous and differentiable in \( y \).

Gandelman (2000) finds evidence that this pattern holds in the Uruguayan Automobile Registration System using a stochastic dominance test on the distribution of car values.
An analogous result can be established for $y^*_2$. ■

Intuitively, when the tax difference is larger, the gains from evading are large, and poorer (more risk-averse) agents can afford to take the risk of evading. If the tax difference is smaller, the gains from evading are small, only richer (less risk-averse) people will be able to afford choosing the lottery of tax evasion.9

2.2 Game Between Local Governments

Local governments set their taxes strategically taking into account the individual decisions on tax evasion in each community.

The game is characterized by introducing the decision rules of individuals—represented by cut-off levels of income $y^*_i$—in the objective functions of the local governments. The values $y^*_i$ determine who evades taxation in each location.

The tax base is formed by local residents who do not evade and foreign residents who evade in their community of origin. In addition, fines are collected from local residents who evade and are caught; by the law of large numbers, they represent a fraction $\pi$ of tax evaders.

The per capita revenue functions of local governments 1 and 2 are given by the following expressions:

$$R_1(T_1, T_2) = \begin{cases} 
1 + \theta^{-1}[1 - \Phi(y^*_2)]T_1 & \text{if } T_1 \leq T_2 \\
\Phi(y^*_1)T_1 + [1 - \Phi(y^*_1)]\pi F & \text{if } T_1 \geq T_2,
\end{cases} \tag{4}$$

$$R_2(T_1, T_2) = \begin{cases} 
\Phi(y^*_2)T_2 + [1 - \Phi(y^*_2)]\pi F & \text{if } T_1 \leq T_2 \\
1 + \theta[1 - \Phi(y^*_1)]T_2 & \text{if } T_1 \geq T_2,
\end{cases} \tag{5}$$

where $[1 - \Phi(y^*_i)] = 1 - \int_y^{y^*_i} \phi(y)dy \geq 0$ is the fraction of individuals that evade taxes in community $i$.

The strategies available to the local governments $i \in \{1, 2\}$ are given by $T_i \in [0, T] \subset \mathbb{R}$.10 The normal form representation of the simultaneous-move game between local governments is $\Gamma_N = \{(1, 2), \{T_1\}, \{R_i\}\}$, where we let $R_i$ denote the payoff functions defined in equations (4-5). The Nash equilibrium of $\Gamma_N$ is defined next.

**Definition 1** A pure strategy equilibrium for this environment is a tax for each community, $(T_1, T_2)$ and cut-off income levels, $y^*_1$ and $y^*_2$, such that:

i) $T_i$ solves the problem of community $i$ given the policy of the other community, $T_j$, for $i, j = 1, 2, i \neq j$, and aggregate decision rules, summarized by cut-off levels $y^*_1$ and $y^*_2$.

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9The potential costs of evasion do not depend on the tax rates, as the fine is constant. If total fines were a linear function of the home tax rate, $F_i = \alpha + \beta T_i$, the penalty of evasion would increase with the evaded tax. In this case, additional restrictions are required to ensure that evasion increases with the local tax rate.

10We define a maximal tax $T < y$ to guarantee the non-negativity of net income.
ii) income levels $y_1^*$ and $y_2^*$ are determined consistently with individual decision problems when residents take policies $(T_1, T_2)$ as given.

It is easy to see that the payoff functions in this game need not be quasiconcave because of the endogenous determination of the tax base. In these cases, there are no general results guaranteeing the existence of pure strategy equilibria, and therefore, a proof of existence cannot be provided in our problem. Although mixed strategy equilibria exist in this environment under continuity of the payoff functions alone (see Glicksberg 1952), we focus our analysis on identifying different properties of pure strategy equilibria.\footnote{In our case, the objective function $R_i$ is continuous if the cut-off level $y_i^*$ is continuous and the income distribution function has no mass points. In the appendix we show that $y_i^*$ is continuous.} We also present a parameterization of the problem that yields a pure strategy equilibrium to illustrate the characteristics of the environment with a numerical example.

3 Size Effects on Policies

In the model, communities may differ only in the size dimension. In this section, we ask whether small communities set lower taxes in equilibrium. In order to examine the effects of differences in community size, we allow for differences in total population, $N_i$. It turns out that having a smaller population allows locations to gain by undercutting the rival’s tax rate and attracting a large mass of evaders. The large location, in contrast, has more to lose by attempting to undercut the smaller rival because of its own large base.

3.1 Identical communities: $N_1 = N_2$

With identical communities we could imagine that an asymmetric situation could be an equilibrium: for example, one community sets lower taxes and attracts the top portion of the population of the rival community, which sets a higher tax on its reduced base. But this intuition is not correct, as shown in proposition 3: with equally sized communities there cannot be an asymmetric equilibrium in pure strategies. Furthermore, it turns out that the only possibility for equilibrium in pure strategies with identical communities is the one in which governments set maximal taxes.

**Proposition 3** Assume $F > 0$ and $\pi > 0$. If $N_1 = N_2 = N$, then in any equilibrium $(T_1, T_2)$, $T_1 = T_2 = \bar{T}$.

**Proof.** Suppose there is an equilibrium with $T_1 \neq T_2$. Without loss of generality, let $T_1 > T_2$. Lemma 2 in the appendix then implies that $T_1 - T_2 > \pi F$. $N_1 = N_2 = N$ implies $\theta = 1$. Since $(T_1, T_2)$ is an equilibrium, we must have

\[
\begin{align*}
R_1(T_1, T_2) &\geq R_1(T_2, T_2) \\
R_2(T_1, T_2) &\geq R_2(T_1, T_1).
\end{align*}
\]
Expanding the payoffs and adding these inequalities we obtain

$$\Phi(y^*_1)T_1 + [1 - \Phi(y^*_1)]\pi F + T_2 + [1 - \Phi(y^*_1)]T_2 \geq T_2 + T_1,$$

which is equivalent to

$$-[1 - \Phi(y^*_1)](T_1 - T_2 - \pi F) \geq 0.$$

By definition of $y^*_1$, $[1 - \Phi(y^*_1)] \geq 0$, and it is only equal to zero if there is no tax evasion. However, if there is no evasion, $R_2(T_1, T_2) = T_2 < T_1 = R_2(T_1, T_1)$, and it would pay jurisdiction 2 to raise taxes. Therefore $[1 - \Phi(y^*_1)] > 0$, which implies that

$$-[T_1 - T_2 - \pi F] \geq 0, \quad \text{or} \quad [T_1 - T_2 - \pi F] \leq 0,$$

which is a contradiction. Thus $(T_1, T_2)$ could not have been an equilibrium.

Now suppose that $(T, T)$ is an equilibrium and that $T < \bar{T}$. In this situation there is no evasion, since it is better for any individual with income $y \in [\underline{y}, \bar{y}]$ to pay taxes in the local jurisdiction,

$$u(y - T) > (1 - \pi)u(y - T) + \pi u(y - T - F).$$

Because the inequality is strict, either community can slightly increase its tax without inducing any evasion and increase its revenue. Therefore $(T, T)$ could not have been an equilibrium.

The difficulty in finding equilibria where tax rates are not maximal lies in the assumption that local governments maximize per capita revenues and have incentives to undercut the rival jurisdiction.

Also, we assume that all individuals must pay taxes. If local governments allowed individuals for whom net income became negative to be exempt from taxation, it might then be possible to find pure strategy equilibria where taxes fall below the maximal tax level. This extension would require using exceptional qualifications for tax evaders, for example, when an individual is only constrained if he gets caught.

### 3.2 Different communities

Motivated by models of tax competition among jurisdictions, a number of studies provide empirical evidence suggesting that larger (or more densely populated) communities tend to set higher taxes. For example, Buettner (2001) identifies a strong positive correlation between population size and property tax rates in a large set of jurisdictions in Germany. Among U.S. states, Hernández-Murillo (2003) also finds a positive correlation between population size and income tax rates. In our model, smaller communities, by fixing a lower tax, can generate extra revenue collected from tax evaders attracted from
the rival community—at the cost of losing revenue from the local population. Intuitively, small communities have more to gain from attracting a larger mass of tax evaders, because the density of their own tax base is small.

Our main result shows that when community sizes differ, the larger community does not set the lower tax.

**Theorem 1** When locations differ in size, in an equilibrium with differentiated tax rates the smaller community will set the smaller tax rate, i.e., if \( T_1 \neq T_2 \) then \( (N_1 - N_2)(T_1 - T_2) > 0 \).

**Proof.** Let \( \theta = N_1/N_2 \neq 1 \) and let \((T_1, T_2)\) be an equilibrium with \( T_1 \neq T_2 \). Without loss of generality, let \( T_1 > T_2 \). We will show that \( N_1 > N_2 \).

By the optimality of the local governments’ choices, in equilibrium we must have

\[
R_1(T_1, T_2) \geq R_1(T_2, T_2) \\
R_2(T_1, T_2) \geq R_2(T_1, T_1).
\]

Expanding we can express these inequalities as

\[
\theta \Phi(y_1^*)T_1 + \theta[1 - \Phi(y_1^*)]\pi F \geq \theta T_2 \\
\{1 + \theta[1 - \Phi(y_1^*)]\}T_2 \geq T_1.
\]

Adding the expressions and manipulating we obtain:

\[
(\theta - 1)(T_1 - T_2) \geq (T_1 - T_2 - \pi F)\theta[1 - \Phi(y_1^*)].
\]

The argument in lemma 2 implies that when \( T_1 > T_2 \), in equilibrium we must have \( T_1 - T_2 > \pi F \). As in the proof of Proposition 3, lemma 2 also implies that there is some evasion, i.e., \([1 - \Phi(y_1^*)] > 0\), and, therefore, it has to be that \( N_1 > N_2 \), since

\[
(\theta - 1)(T_1 - T_2) > 0.
\]

The smaller jurisdiction has strong incentives to undercut its larger rival’s rate to induce evasion in that community. In order to sustain evasion in equilibrium, however, the difference in tax rates generated by undercutting from the small community has to exceed the expected payment of fines.

We cannot, in general, rule out a symmetric equilibrium with no evasion if fines are sufficiently high. For example, if \( T \leq \pi F \), then we can verify that \((\overline{T}, \overline{T})\) is an equilibrium and that there is no other equilibrium with \( T_1 \neq T_2 \). Suppose that \( N_1 > N_2 \), then the least risk-averse resident in jurisdiction 1 has no incentives to evade because

\[
\overline{y} - \overline{T} > (1 - \pi)(\overline{y} - T_2) + \pi(\overline{y} - T_2 - F),
\]

(6)
regardless of the tax rate in the small location, \( T_2 \). Jurisdiction 2’s best response in this case is to set \( \overline{T} \) as well.

With the same argument as in Proposition 3 it can be shown, however, that the maximal taxation equilibrium is the only possibility for a symmetric equilibrium.

An interesting question that arises is whether a similar result can be established if instead of examining large and small communities, we looked at rich vs. poor jurisdictions, as it is often done when analyzing population migration models in the spirit of Tiebout (1956). It turns out that examining the effects of differences in income distribution, normalizing \( N_1 = N_2 = 1 \) and allowing the density functions, \( \phi_i \), to vary, does not yield a clear characterization, as in the case of size differences. If we define community 1 to be richer than community 2 when \( \Phi_1(x) \leq \Phi_2(x) \) for all \( x \in [y, \overline{y}] \), then there will be two opposing effects. Taking the tax rate of the rich community as given, the poor community, by setting a lower tax, can attract the top portion of the rich community—a stealing effect—but it can also set a higher tax to increase local revenues, knowing that its local residents will probably not take the chances of evasion—a capturing effect. In general, it is not possible to determine which effect dominates.\(^{12}\)

### 3.3 An Example

As we discussed before, the mobility of the tax base implies that the payoff functions of the local governments need not be quasiconcave, and therefore we cannot establish general results on the existence of pure strategy equilibria. In what follows we present a parameterized example of an asymmetric equilibrium in pure strategies that illustrates the results presented before.

We assume that all individuals have the same utility function over net income given by the extended power utility function (see Huang and Litzenberger 1988)

\[
u(y) = \frac{1}{B - 1}(A + By)^{1-\frac{1}{B}}, \quad B > 0, A \neq 0, \tag{7}\]

and we assume that the income distribution in both locations is given by a bounded Pareto distribution

\[
\Phi(y) = \left( \frac{y\overline{y}}{\overline{y} - y} \right) \left( \frac{y - y}{y\overline{y}} \right), \tag{8}\]

\(^{12}\)For example, let community 1 have a degenerate distribution at some income level \( \hat{y}_1 \). Then it has to be true that \( T_1 \leq T_2 \). In an equilibrium with \( T_1 > T_2 \) there cannot be any tax evasion in community 1. The reason is that since all individuals are identical, tax evasion would imply that everyone evades and revenues are zero. The government in community 1 could then increase revenues by setting the same tax as the rival community. Now, because there is no evasion in community 1, \( R_2(T_1, \overline{T}) = \overline{T} < R_2(T_1, T_1) = T_1 \), a contradiction. Note that we made no assumption on the income level of community 1. In particular, the example holds if \( \hat{y}_1 = \overline{y}_2 \) or \( \hat{y}_1 = \underline{y}_2 \).
where \( y \) and \( \overline{y} \) are the lower and upper bounds of the income distribution, respectively. Finally, we use the following parameter values:

\[
\begin{array}{c|c|c|c}
 y & N_1 & A \\
\hline
15 & 80 & 0.1 \\
\hline
\overline{y} & N_2 & B \\
\hline
150 & 1 & 0.2 \\
\hline
F & \pi & T \\
\hline
6 & 0.2 & 10.
\end{array}
\]

This parameterization does not pretend to be realistic, it is merely useful to illustrate the characteristics of the environment.

We solve for the equilibrium numerically. It turns out that the equilibrium in this case is unique and asymmetric: The large community sets the higher tax rate, and the maximal tax rate is not binding. The equilibrium is given by \((T_1, T_2) = (2.1, 0.4)\). Figures 3(a) and 3(b) present the payoff functions at the Nash equilibrium.

Panel (a) shows the per capita revenues of jurisdiction 1, drawn setting the tax rate in community 2 at its equilibrium value, \( T_2 = 0.4 \). The different regions of this chart can be summarized as follows. First, there is a section where payoffs increase linearly at a constant rate of 1. In this region there is no tax evasion and jurisdiction 1 collects taxes only from its own residents, with no influx from location 2. Second, as the tax rate in location 1 continues to increase, revenues increase at decreasing rates and eventually decrease. This is because some residents in jurisdiction 1 become tax evaders. Finally, as the tax rate in location 1 approaches 3.5, all residents evade taxation, and the only revenues collected are from evaders who are caught. Notice that the optimal tax rate in location 1 is given by the interior solution \( T_1 = 2.1 \), as the payoff function is locally concave around the maximum. At the optimum, per capita revenues are given by \( R_1(T_1, T_2) = 1.8 \), and total revenues by \( N_1R_1(T_1, T_2) = 144.7 \).

Panel (b) presents the per capita revenues of jurisdiction 2, drawn setting the tax rate in community 1 at its equilibrium value, \( T_1 = 2.1 \). This chart can also be summarized by looking at different regions. First, the low tax rate in jurisdiction 2 generates evasion in jurisdiction 2, and the influx of residents from that location is reflected in the smooth region of the function. As the tax rate in location 2 continues to increase, evasion is very quickly discouraged and revenues decline as the influx of residents from the larger community is reduced. Second, once evasion stops, revenues in location 2 continue to increase linearly, implying that the local tax base in jurisdiction 2 is composed of its residents exclusively. Notice that this occurs, even after \( T_2 \) exceeds the equilibrium value of \( T_1 \). Finally, as the tax rate in location 2 continues to increase, residents in this location decide to evade taxation. Notice that the optimal tax rate in location 2 also occurs at an interior tax level in the smooth region of the payoff function. At the optimum, per capita revenues are given by \( R_2(T_1, T_2) = 11.6 \). Since \( N_2 = 1 \) in this example, per capita revenues are equal to total revenues. Notice also that, in accordance with lemma 2, \( T_1 - T_2 = 1.7 > 1.2 = \pi F \).

The payoff function in panel (b) has two local optima. The second one occurs around the point where the residents of the small jurisdiction decide to evade. This optimum
Figure 3(a): Payoff Function of the Large Community

Figure 3(b): Payoff Function of the Small Community
occurs at a kink in the function, but this need not be the case. The important aspect is that there are two optima. This feature implies that the corresponding best-reply function will have a discontinuity. This is illustrated in Figure 4. The best-reply function of the small jurisdiction is shown with a solid line. The best-reply function is discontinuous: it takes a down-jump when it pays location 2 to undercut the large jurisdiction by lowering its tax rate. The best-reply function of the large jurisdiction does not have a discontinuity and it is always above the 45 degree line, implying that it never pays jurisdiction 1 to undercut the small jurisdiction.

Finally, Figure 5 illustrates the evasion decisions of the residents in jurisdiction 1. This function depicts the level of income of the marginal tax evader in jurisdiction 1. We can see that the function is continuous and is increasing in $T_2$ and decreasing in $T_1$. At the Nash equilibrium, the marginal resident of jurisdiction 1 has an income of $y_1^*(T_1, T_2) = 38.3$, which implies that the fraction of agents who evade taxes in this community is equal to $1 - \Phi(y_1^*(T_1, T_2)) = 0.32$.

4 Tax Harmonization

In this section we examine, as one approach to policy coordination, the plausibility of tax harmonization and its effects on fiscal revenues. In a strict sense our analysis is not a welfare analysis since we will focus only on per capita fiscal revenue. We want to know (1) whether it is possible to implement harmonization of tax policies, such that
each community improves, (2) under what conditions would this be possible, and (3) how would this affect revenue collection in both communities. Clearly, setting both tax rates at the maximal level guarantees joint revenue maximization, but imposing this tax rate may not be politically feasible. A natural candidate, in terms of political feasibility, for a harmonized tax rate is a weighted average of the non-cooperative equilibrium rates. The next two subsections show that the smaller community will oppose any intermediate tax rate, unless it is compensated.

4.1 Harmonization with Transfers

First we restrict our analysis to the possible joint revenue gains from harmonization to a common tax rate, $T^h$, without discussing for the moment the incentives of each community to deviate from the agreement. We can think of this harmonization scheme as imposed by a federal government with the local governments forced to comply, or as an agreement with transfers between communities. Clearly, the interesting case to discuss is when tax rates differ in the non-cooperative equilibrium.

---

13 Allowing competition in enforcement policies (audit probability and evasion fine) is beyond the scope of the current analysis, since our focus is on tax policies. Presumably, competition in enforcement policies would continue even if coordination in tax policies could be achieved, as harmonization of the former would be more costly.
Let \((T_1, T_2)\) be an equilibrium for \(N_1 > N_2\). Let \(T^h\) denote the harmonized common tax rate. To facilitate exposition we will abbreviate notation letting \(\Phi = \Phi(y_1^*).\) Therefore,

\[
R_1(T_1, T_2) = \Phi T_1 + (1 - \Phi) \pi F
\]

\[
R_2(T_1, T_2) = T_2 + \theta (1 - \Phi) T_2.
\]

(9)

(10)

It is not obvious that a harmonized common tax rate will lead to maximal joint per capita revenues since it may be optimal (for a joint maximizer) to allow some evasion with differentiated tax rates, given that there is a percentage \(\pi\) of all evaders that end up paying the tax rate of one community plus the fine of the other.

It turns out that if transfers can be implemented between communities, there is always a minimum common tax rate such that both communities benefit from harmonization and it is intermediate to the tax rates in the non-cooperative equilibrium.

**Proposition 4** Let \(\tilde{T} \equiv \Phi T_1 + (1 - \Phi) (T_2 + \pi F),\) then communities will jointly benefit from harmonization if and only if \(T^h \geq \omega \tilde{T} + (1 - \omega) T_2,\) where \(\omega \equiv \frac{\theta}{1+\theta}.

**Proof.** Harmonization optimizes joint revenues per capita:

\[
\frac{N_1 R_1(T^h, T^h) + N_2 R_2(T^h, T^h)}{(N_1 + N_2)} = \omega R_1(T^h, T^h) + (1 - \omega) R_2(T^h, T^h) = T^h.
\]

We compare this with the value of the objective at the non-cooperative equilibrium rates:

\[
\omega R_1(T_1, T_2) + (1 - \omega) R_2(T_1, T_2) = \omega \{\Phi T_1 + (1 - \Phi) \pi F\} + (1 - \omega) \{T_2 + \theta (1 - \Phi) T_2\}
\]

\[
= \omega \{\Phi T_1 + (1 - \Phi)(T_2 + \pi F)\} + (1 - \omega) T_2
\]

\[
= \omega \tilde{T} + (1 - \omega) T_2,
\]

where we have used that \((1 - \omega) \theta = \omega.\)

By lemma 2, in equilibrium \(T_1 > T_2 + \pi F,\) then \(\tilde{T} < T_1\) and therefore \(T_2 < \omega \tilde{T} + (1 - \omega) T_2 < T_1.\) That is, the minimum harmonization tax rate required to guarantee larger joint per capita revenues than those in the non-cooperative equilibrium is strictly between the two non-cooperative tax rates. Imposing the maximal tax rate, \(\tilde{T},\) in both locations would clearly maximize joint per capita revenues subject to the constraint of requiring a common tax rate. However, coordinating to an intermediate tax rate would be politically more feasible in most situations.

**4.2 Harmonization without Transfers**

If transfers between communities cannot be implemented, possibly because they are costly in terms of coordination or because the political implications are not desirable for
the local governments, in order for jurisdictions to agree on harmonizing policies, individual payoffs need to improve for both local governments. Thus we impose the condition that each community has to be at least as well off with the harmonized tax as in the non-cooperative equilibrium. This harmonized taxation may be the result of explicit negotiations between communities or we can think of it as an implicit collusion outcome of the game played repeatedly over infinite periods with a sufficiently high discount factor.\textsuperscript{14}

Proposition 5 illustrates that when transfers are not available, the smaller location will demand a harmonized tax rate that exceeds the largest tax rate of the non-cooperative equilibrium. This determines a lower bound on the harmonized tax rate. As this lower bound is higher than the higher tax of the non-cooperative equilibrium, under the harmonized tax regime agents’ disposable income will be smaller than in the non-cooperative equilibrium and therefore all residents in both locations will be worse off. A possible justification for undertaking harmonization in this situation would be that it increases the consumption of the public good financed with tax revenues (something we do not model) and that this compensates for the decrease in the consumption of private goods.

**Proposition 5** If \((T_1, T_2)\) is an equilibrium with \(T_2 < T_1\),

a) Neither community benefits from a common tax rate lower than the smaller community’s non-cooperative tax rate \(T^h < T_2\).

b) The smaller jurisdiction never benefits from an intermediate common tax rate \(T^h\) with \(T_2 \leq T^h < T_1\).

c) If the smaller jurisdiction benefits from harmonization then the larger jurisdiction will benefit also.

**Proof.**

a) The smaller jurisdiction does not benefit from harmonization since it would not collect taxes from evaders and it would collect lower taxes from its own residents.

\[
R_2(T^h, T^h) = T^h < T_2 < \{1 + \theta(1 - \Phi)\}T_2 = R_2(T_1, T_2).
\]

The larger community does not benefit from a tax rate below \(T_2\) either, as

\[
R_1(T_1, T_2) \geq R_1(T_2, T_2) = T_2 > T^h = R_1(T^h, T^h),
\]

where the first inequality follows because \(T_1\) is a best response to \(T_2\).

b) If we harmonize to the smaller tax rate, \(T^h = T_2\), then

\[
R_2(T_1, T_2) = \{1 + \theta(1 - \Phi)\}T_2 > T_2 = T^h = R_2(T^h, T^h).
\]

\textsuperscript{14}In the short run communities have an incentive to deviate. Therefore harmonized taxation would be a subgame-perfect Nash equilibrium only if the present value of future losses from not cooperating today were high enough.
If we harmonize to an intermediate tax rate, \( T_2 < T^h < T_1 \),

\[
R_2(T_1, T_2) \geq R_2(T_1, T_1) = T_1 > T^h = R_2(T^h, T^h).
\]

c) The above two results imply that \( T^h \geq T_1 \) is a necessary condition for jurisdiction 2 to benefit from harmonization. We can see that this is a sufficient condition for jurisdiction 1 to benefit as well:

\[
R_1(T_1, T_2) = \Phi T_1 + [1 - \Phi] \pi F < T_1 \leq T^h = R_1(T^h, T^h),
\]

where the first inequality follows from lemma 2 since \( T_1 > \pi F \) in equilibrium.

The next proposition characterizes the conditions under which harmonization would garner benefits for both local authorities.

**Proposition 6** If there can be no transfers between jurisdictions, communities can benefit from harmonization if and only if

\[
T^h \geq \max\{[1 + \theta (1 - \Phi)]T_2, T_1\}.
\]

**Proof.** The per capita revenues of each community in the harmonized scheme must be larger than in the non-cooperative case. Consider first the smaller community: \( R_2(T^h, T^h) \geq R_2(T_1, T_2) \) if and only if \( T^h \geq \{1 + \theta (1 - \Phi)\}T_2 \). Also, by proposition 5, the smaller jurisdiction will not benefit if the harmonized tax rate is less than \( T_1 \), therefore the stated condition must hold. From part (c) in proposition 5, the larger community will benefit also.

The larger jurisdiction would benefit from harmonization with a tax rate even smaller than \( T_1 \) since evasion would be prevented in the harmonized environment. The necessary condition for the larger community to benefit from a harmonized tax rate is

\[
T^h \geq T_1 - [1 - \Phi][T_1 - \pi F].
\]

However, a common tax rate equal to the right-hand side would harm the smaller jurisdiction. The premium the small jurisdiction has to receive in terms of a higher common tax rate is proportional to the fraction of evaders from the large location in the non-cooperative equilibrium. Therefore, whenever the smaller community agrees to harmonize taxes, the larger one will as well.

**5 Conclusion**

The model developed in this paper examines tax competition in a framework with residence-based taxation in which authorities can only imperfectly monitor the origin of taxpayers.
who may choose to evade local taxation by pretending to be residents of the rival low-tax community. We characterize the properties of equilibria in pure strategies when communities differ in size and find that small communities have advantages in capturing some tax base from their rival by undercutting their higher tax rate. No such characterization is possible in the present framework for differences in income level and income distribution.

We also characterize the problem facing individual residents who evaluate the payoffs of complying with local taxation and the resulting lottery of evasion. Decreasing risk aversion implies that only high-income agents can afford to choose tax evasion. This feature is comparable to the results of existing models of cross-border shopping in spatial frameworks with risk-neutral individuals, where only agents with high valuation (net of transportation costs) cross borders to shop in the low tax community.

Our model clearly indicates that integration, in the sense of joint revenue maximization, can always be beneficial from the perspective of local governments. If communities have a way to make side transfers between them, then the minimum tax rate required to generate joint benefits in the harmonization scheme is strictly between the two non-cooperative tax rates. This is important if coordinating to a different tax rate is more costly. We find that, even without side transfers, there are potentially important benefits from harmonization. The minimum agreeable tax rate has to guarantee a premium to the small community over the non-cooperative tax rate. This premium is proportional to the fraction of tax evaders in the large community. The resulting tax rate is larger than the non-cooperative tax rates. Therefore, although harmonization improves the fiscal situation of the local governments, assessing the welfare implications of harmonization would require considering the substitution of consumption of private goods for public goods, an aspect we do not analyze.

The implications of the model seem to be in line with casual evidence for some regions of the United States and preliminary evidence for Uruguay, where statistical correlation between community size and the distribution of car values across municipalities, as well as between size and magnitude of registration fees, have been found.

In a more general analysis of policy coordination, particularly between countries, it would be interesting to study the larger version of a game where both tax and monitoring policies can be used strategically. Presumably, even when some type of coordination can be achieved with respect to tax policies, harmonization of monitoring efforts is more costly.

Finally, in our framework, lump-sum tax policies imply that relatively less risk-averse agents can avoid high taxes by fleeing to another community. This feature makes the head tax structure regressive. Presumably, a federal authority in charge of choosing an optimal tax structure superseding fiscal competition would take into account attitudes toward risk in its design.
Appendix

Define

\[ U(y, T_1, T_2) = u(y - T_1) - (1 - \pi)u(y - T_2) - \pi u(y - T_2 - F). \]

**Lemma 1** If \((T_1, T_2)\) are tax rates such that \(y^*_1 \in (y, \overline{y})\), then \(\left. \frac{\partial U(y, T_1, T_2)}{\partial y} \right|_{y = y^*_1} < 0\).

**Proof.** Note that \(U(y^*_1, T_1, T_2) = 0 \iff y^*_1 - c(y^*_1, T_2) = T_1\). The assumption of DARA implies \(\frac{\partial[y - c(y, T_2)]}{\partial y} < 0\), and therefore \(\frac{\partial c(y, T_2)}{\partial y} > 1\). From the definition of \(c(y, T_1, T_2)\), we have \(u'(c(y, T_2))\frac{\partial c(y, T_2)}{\partial y} = (1 - \pi)u'(y - T_2) + \pi u'(y - T_2 - F)\), which implies \((1 - \pi)u'(y - T_2) + \pi u'(y - T_2 - F) > u'(c(y, T_2))\) for all \(y\). Finally we have:

\[
\left. \frac{\partial U(y, T_1, T_2)}{\partial y} \right|_{y = y^*_1} = u'(y^*_1 - T_1) - (1 - \pi)u'(y^*_1 - T_2) - \pi u'(y^*_1 - T_2 - F) < u'(y^*_1 - T_1) - u'(c(y^*_1, T_2)) = 0.
\]

The last equality follows from the definition of \(c(y, T_2)\) and \(y^*_1\) interior. ■

**Lemma 2** If \((T_1, T_2)\) is an equilibrium with \(T_1 \neq T_2\), then \(|T_1 - T_2| > \pi F\).

**Proof.** Without loss of generality, let \(T_1 > T_2\). Now suppose there is an equilibrium \((T_1^*, T_2^*)\) where \(T_1 - T_2 \leq \pi F\). Then \(T_1 - T_2 \leq \pi F\) implies that \(y - T_2 - \pi F \leq y - T_1\) for any \(y\) in community 1. Rewriting, we have that \((1 - \pi)(y - T_2) + \pi(y - T_2 - F) = y - T_2 - \pi F \leq y - T_1\). That is, the expected payoff to evading taxes is less than the payoff to paying taxes at home, and no one in community 1 would choose to evade since risk aversion implies \(u'(y - T_1) \geq (1 - \pi)u'(y - T_2) + \pi u'(y - T_2 - F)\). Therefore, since \(R_2(T_1, T_2) = T_2\) and \(T_2 < T_1 \leq \overline{T}\), it would pay community 2 to raise its tax rate \(T_2\), and therefore \((T_1, T_2)\) could not be an equilibrium. ■

**Lemma 3** The cut-off income level, \(y^*_1\), defined in equation (1) is continuous in \((T_1, T_2)\).

**Proof.** It is enough to show continuity for tax policies \((T_1, T_2)\) such that \(y^*_1 \in (y, \overline{y})\). Given tax rates \((T_1, T_2)\), an agent with income \(y\) in community 1 decides to evade if \(U(y, T_1, T_2) < 0\). Since

\[
\left. \frac{\partial U(y, T_1, T_2)}{\partial y} \right|_{y = y^*_1} < 0,
\]

by lemma 1; the implicit function theorem then implies that the function \(y^*(T_1, T_2)\) such that \(U(y^*(T_1, T_2), T_1, T_2) = 0\) is continuous in the set of policies \((T_1, T_2)\). ■
References


