A Nash tax game extending the generality of the Henry George Theorem

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Abstract

This paper analyzes a model of Nash tax competition where jurisdictions can finance public goods with taxes on two types of mobile capital and a tax on land. Efficiency in public good provision results when the land tax becomes the single tax required to fund local government spending. This conclusion affirms and extends the generality of the Henry George Theorem.

Keywords: Tax competition; Efficiency; Optimal taxation

JEL classification: H73; H21

1. Introduction

A vast literature now exists regarding interjurisdictional tax competition for business capital and its welfare implications. The common result of this body of work is that localities set capital tax rates too low and local public goods are underprovided. This inefficiency is said to stem from a fiscal externality (see, e.g., Wildasin, 1989), created by the tax competition. An interesting variation on this theme is the consequence of jurisdictions competing for two ‘types’ of capital inputs. The argument centers on the notion that capital types contribute to a region’s production process heterogeneously and should receive differential tax treatment, thus enhancing a jurisdiction’s welfare. While the general outcome of this capital type tax competition follows the persistent underprovision of public goods conclusion, one could argue that the resulting inefficiency stems from a location’s limitation of tax instruments and not the purported fiscal externality.

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1See Wilson (1999) and Braid (1996) for extensive reviews.
2For example, see Smith (1999). Parallels are lifted from the commodity tax literature.
3This point is made quite forcefully by Myers (1990) for the free population mobility case.
The focus of this paper is to relax the limitations on a location’s tax-regime by allowing jurisdictions to tax land as well as two distinct types of capital. Taxing land is a realistic augmentation to a jurisdiction’s tax structure. Nearly all local taxing authorities in the US tax land and capital, but few have the authority to directly tax ‘heads’.4

The inclusion of a land tax insures a jurisdiction’s efficient provision of public goods by becoming the single tax required to finance public expenditures. This conclusion affirms and extends the generality of the dubbed ‘Henry George Theorem’ (George, 1914) beyond previous studies.5

2. The Model

The economy is divided into two large symmetric jurisdictions (aka, local regions), indexed by \(i\), each containing a fixed number of identical residents. Each jurisdiction is endowed with a type I capital ownership share ‘\(\theta_i\)’, of the fixed national type I capital stock \(K\), a type II capital ownership share ‘\(\phi_i\)’, of the fixed national type II capital stock \(C\) and an exogenous amount of internally owned land, \(L\).6 Land and capital shares are owned equally throughout each jurisdiction. Each region produces a single homogeneous good which serves as the numeraire. Jurisdictions possess homogenous, constant returns to scale, technologies \(f(K_i, C_i, L)\), where \(K_i\) is the endogenous amount of type I capital employed in jurisdiction \(i\) and \(C_i\) is the endogenous level of type II capital employed. In order to simulate a meaningful economy, the following conditions on production are assigned, \(f_K, f_C, f_L > 0, f_{KK}, f_{CC}, f_{KL} < 0\) and the following concavity condition is imposed, \(A = f_{KK}f_{CC} - (f_{KC})^2 > 0\). Applying Euler’s theorem to production,

\[
f = f_K K_i + f_C C_i + f_L L_i, \tag{1}
\]

while differentiating (1) yields,

\[
f_{KK} K_i + f_{KC} C_i + f_{KL} L_i = 0, \tag{2}
\]

where ‘\(\beta\)’ can equal \(K\), \(C\) or \(L\).

Three jurisdictional tax rates are analyzed: (1) ‘\(\tau\)’ is a source based unit tax on type I capital; (2) ‘\(\tau\)’ is a source based unit tax on type II capital; and (3) ‘\(a\)’ is a unit tax on immobile land.7

Both types of capital are fully mobile under the binding constraints,

\[
K_1 + K_2 = \bar{K} \quad \text{and} \quad C_1 + C_2 = \bar{C}. \tag{3}
\]

Large jurisdiction tax competition implies some level of market power with regard to a region’s influence on returns to mobile factors. Variables ‘\(r\)’ and ‘\(\rho\)’ represent the endogenous net returns to types I and II capital, respectively. Mobile factor equilibrium conditions are,

\[\text{See Hoyt (1991) and Braid (1996) for a discussion of jurisdictional taxation in the US.}\]
\[\text{As developed in, for example, Arnott and Stiglitz (1979).}\]
\[\text{The immobile factor could be reinterpreted as labor rather than land.}\]
\[\text{This construct is similar to Krelove (1993) and Bucovetsky (1995) where the land tax is determined as the residual. The model bears similarities to a situation where the two mobile factors are a single type of capital and labor.}\]
which insure that the net price of capital inputs is equal to the after tax value of its marginal product. Eqs. (3) and (4), the latter for \( i = 1, 2 \), provide the necessary \( 2i + 2 \) system of equations required to determine \( K_i, C_i, r \) and \( \rho \) as functions of the tax rates \( t_i \) and \( \tau_i \). Because \( K_i, C_i, r \) and \( \rho \) cannot be solved for explicitly, it is necessary to derive various comparative statics on the system above. The following is a summary of the relevant comparisons

\[
\frac{\partial K_i}{\partial t_i} = \frac{f_{CC}}{2A} < 0, \quad \frac{\partial K_i}{\partial \tau_i} = -\frac{f_{KC}}{2A},
\]

\[
\frac{\partial C_i}{\partial t_i} = -\frac{f_{KC}}{2A}, \quad \frac{\partial C_i}{\partial \tau_i} = \frac{f_{KK}}{2A} < 0,
\]

with equilibrium net capital return effects,

\[
\frac{\partial r}{\partial t_i} = \frac{\partial \rho}{\partial \tau_i} = -\frac{1}{2}, \quad \frac{\partial r}{\partial t_i} = \frac{\partial \rho}{\partial t_i} = 0.
\]

Output from production of each jurisdiction is consumed as a composite private good, \( x_i \), or supplied to the local government to produce a public good, \( G_i \). The public good is financed by the taxes on capital and land, in each jurisdiction. All local government revenue is spent on the public good so that total expenditure becomes,

\[
G_i = t_i K_i + \tau_i C_i + a_i L_i.
\]

Total consumption in each region is equal to output plus the value of net capital exports,

\[
x_i + G_i = f(K_i, C_i, L_i) + r(\theta_i \bar{K}_i - K_i) + \rho(\phi_i \bar{C}_i - C_i).
\]

Local governments are assumed benevolent dictators that maximize the utility of regional residents. A region’s residents derive utility from consuming the localized public good and the private good. Utility is defined by the well behaved function, \( u(G_i, x_i) \).

The optimal provision of jurisdictional public goods can be expressed by the following simple tenet in the Samuelson spirit. In each region, \( G_i \) is chosen to maximize \( u \) for a given level of production. The problem result yields,

\[
MRS_{G,x} = \frac{\partial u/G_i}{\partial u/x_i} = 1,
\]

where the regional marginal rate of substitution equals the marginal rate of transformation which equals one. A marginal rate of substitution greater than unity implies an underprovision of the local public good.

Jurisdictional governments play a Cournot/Nash game in tax rates. Each region will choose \( t_i \) and \( \tau_i \) to maximize the common utility of its residents, subject to given tax policies of other governments. Considering the taxation choices regional governments face, it is necessary to derive regional best

\[
^8 \text{Assumes convex indifference curves that do not touch the axes, hence, no corner solutions.}
\]
response (reaction) functions. Differentiating (9) with respect to tax rates \( t_i \) and \( \tau_j \), substituting in (4) and (7) yields,

\[
(t_i): \quad \frac{\partial x_i}{\partial t_i} + \frac{\partial G_i}{\partial t_i} = t_i \frac{\partial K_i}{\partial t_i} + \tau_i \frac{\partial C_i}{\partial t_i} - \frac{1}{2}(\phi_i K_i - K_i),
\]

(11)

\[
(\tau_j): \quad \frac{\partial x_j}{\partial \tau_j} + \frac{\partial G_j}{\partial \tau_j} = t_j \frac{\partial K_j}{\partial \tau_j} + \tau_j \frac{\partial C_j}{\partial \tau_j} - \frac{1}{2}(\phi_j C_j - C_j).
\]

(12)

The following assumption is necessary to evaluate (11) and (12) at the symmetric equilibrium; regional capital ownership is equal hence, \( \theta_i = \phi_i = 1/2 \), therefore, \( \theta_i K_i = K_i \) and \( \phi_i C_i = C_i \).

A region’s optimal choice of \( t_i \) and \( \tau_j \) must satisfy the utility maximizing conditions,

\[
(t_i): \quad \frac{\partial x_i}{\partial t_i} + \text{MRS}_{G,x} \frac{\partial G_i}{\partial t_i} = 0,
\]

(13)

\[
(\tau_j): \quad \frac{\partial x_j}{\partial \tau_j} + \text{MRS}_{G,x} \frac{\partial G_j}{\partial \tau_j} = 0.
\]

(14)

Combining (11), (12) with (13), (14) (evaluated at the symmetric equilibrium) and differentiating (8) with respect to \( t_i \) and \( \tau_j \) yields the best response functions,

\[
[MRS_{G,x} - 1] \left[ t_i \frac{\partial K_i}{\partial t_i} + K_i + \tau_j \frac{\partial C_i}{\partial t_i} \right] = - t_i \frac{\partial K_i}{\partial t_i} - \tau_j \frac{\partial C_i}{\partial t_i}
\]

(15)

\[
[MRS_{G,x} - 1] \left[ t_j \frac{\partial K_j}{\partial \tau_j} + C_j + \tau_j \frac{\partial C_j}{\partial \tau_j} \right] = - t_j \frac{\partial K_j}{\partial \tau_j} - \tau_j \frac{\partial C_j}{\partial \tau_j}
\]

(16)

Substituting (5), (6) into (15), (16), solving simultaneously for \( t_i \) and \( \tau_j \), and using (2) yields the optimal regional tax rates,

\[
t_i = 2f_{L,K}L \left[ 1 - \frac{1}{\text{MRS}_{G,x}} \right] \quad \text{and} \quad \tau_j = 2f_{L,C}L \left[ 1 - \frac{1}{\text{MRS}_{G,x}} \right].
\]

(17)

Eq. (17) must be satisfied as long as each regional government can tax both types of capital, whether or not a land tax is available. Moreover, Eq. (17) are analogous to the optimal tax rules in Smith (1999), yielding a similar interpretation, though Smith’s analysis considers the case of many small jurisdictions.

3. Result and concluding comment

Given that a land tax is available, the same procedure used to derive (11)–(16) must apply to \( a_i \). Since \( L \) is fixed, and mindful that varying \( a_i \) does not effect \( K_i \) or \( C_i \), it is easily shown that the land tax equation, analogous to (15) and (16), is

\[\text{Details of this derivation are available from the author, upon request, in an unpublished Appendix A.}\]
\[ [MRS_{G,x} - 1] \cdot L = 0. \]  \hspace{1cm} (18)

Therefore, \( MRS_{G,x} = 1 \), regardless of the availability of capital taxes. From (17), the capital taxes are chosen to be zero even when they are available. Subsequently from (8), \( G_i = a_i L \), where the efficient public good expenditure equals revenues raised solely from the land tax which are not zero (see footnote 8). The land tax emerges as the complete tax structure of a jurisdiction. Under this Nash construct, the land tax is not necessarily confiscatory of total land rents. Heedful of this caveat, the Henry George Theorem holds more generally than historically hypothesized.

Acknowledgements

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References