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Capital taxation with population control

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Abstract

Excessive population growth or hostility against immigrants has induced government adoption of population control measures, e.g., housing regulations and restrictive immigration laws. As labor supply becomes constrained by such measures, capital returns decrease, so that governments might want to lower taxation to avoid an ensuing capital flight. However, population control also reduces the potential congestion in the use of government-provided goods, making taxation marginally more beneficial, so a higher tax rate may be optimal when there is significant congestion.

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1 Introduction

Although population growth can add needed workers and valuable human capital, governments often adopt policies that restrain the growth of local population in attempt to avoid issues like congestion in the use of government services and infrastructure, environmental damage, or loss of open space (see Brueckner, 2009, on the motivations for local land use regulations that restrict population growth). At the national level, public hostility against foreign immigrants due to greater competition for jobs, fear of increased crime rates, or discrimination is also an important factor in the adoption of border control measures (Hollifield et al., 2014). For instance, the desire to regain control over immigration was a major driver of the recent decision of the UK to leave the European Union (Schmidtke, 2021).

At the local and regional levels, population control takes the form of housing supply restrictions (e.g., through zoning, construction requirements, urban growth or service boundaries, fringe development restrictions, and impact fees; Brueckner, 1999) or policies that are unattractive to certain households, usually the poor or foreigners (e.g., large lot zoning, density restrictions, language requirements, and unfavorable income redistribution; see Brueckner and Glazer, 2008, for the literature on exclusionary policies). Theoretical models analyzing the motivations of local population growth controls have been developed by Brueckner (1990), Engle et al. (1992), Brueckner (1995), and Helsley and Strange (1995).[1]

At the national level, population control typically takes the form of immigration restrictions (see Schmidtke, 2021, for policies adopted around the world).

The current paper studies the effects of population control on the taxation of mobile capital. As population control restricts the growth of the labor supply, capital returns are negatively affected.[2] In response to capital flight, governments may be tempted to lower capital tax rates.[3] For instance, recently, in Brexit discussions, there were speculations that tax rates would have to be lowered in the UK to lure investments and jobs after the country's exit from the European Union (Fuest and Sultan, 2019).

However, population control has a counteracting effect on the incentive to tax: it reduces the potential congestion in the use of public goods, thus increasing the marginal benefit of taxation.[4] Therefore, population control has ambiguous effects on capital taxation: lower tax rates are needed to avoid capital flight, but greater taxation may be desirable as the use

[1]Fischel (1990) reviewed evidence on the effects of controls, especially on the increased housing price. See Brueckner (1999) for a comprehensive survey of the earlier urban growth control literature, which focuses mostly on the resulting increased housing costs and diversion of population growth to neighboring cities.

[2]Sasaki (1998) and Ogura (2005) showed that population growth controls increase wage rates, but they ignored capital mobility and taxation. Glaeser et al. (2006) pointed out that construction regulations in the Boston area were hurting businesses due to the higher wages needed to be paid as a result of higher housing costs. For similar reasons, some businesses seem to have moved out of Santa Barbara, a growth-controlling city in California (J. Rabin and D. Kelley, 'Slow Growth' has come at a cost in Santa Barbara, Los Angeles Times, 3/6/2006, p. A1). Population controls may also discourage new business investments by curtailing agglomeration economies in the regional production (Nandwa and Ogura, 2013). At the national level, Hollifield et al. (2014) discussed how industrialized countries have attempted to conciliate the need for foreign labor with immigration restrictions induced by political, legal, and security concerns.

[3]Zodrow and Mieszkowski (1986) and Wilson (1986) developed models of capital tax competition. In this setting, population mobility was introduced by Wilson (1995) and Brueckner (2000). See Wilson (1999) for a comprehensive survey of the earlier literature.

[4]Sasaki (1998) studied how congestion in public goods induces adoption of growth controls.

of government-provided goods and services becomes less congested.

The remainder of the article is organized as follows. Section 2 presents the setup of the model. In Section 3, the optimal tax rate choice is analyzed in the cases of free migration and population control. Concluding remarks follow.

2 Model setup

2.1 Overview

The model setting follows the urban growth control and tax competition literature (see Brueckner, 1999, and Wilson, 1999, respectively).

Without population control, markets are competitive and there is perfect capital and labor mobility. With control, population growth is constrained, so that population is reduced compared to the free migration case.

Each jurisdiction is considered to be identical and small relative to the entire economy, so that there is no strategic government choice relative to other governments' policies. In equilibrium, capital mobility implies that the net capital return is the same everywhere. With free migration, households obtain the same equalized utility anywhere in equilibrium.

2.2 Production

Labor is supplied by households, each providing one unit of labor in the residing region, so that the regional labor supply (denoted by N) equals the population of households. Capital, on the other hand, can be invested in any place without moving costs, with the amount owned by each household normalized to one unit.

Production of the private good by competitive firms in each region is represented by the function $F(K, N)$. Constant returns to scale (CRS) and the usual assumptions apply, i.e., with derivatives $F_K > 0$, $F_N > 0$, $F_{KK} < 0$, $F_{NN} < 0$, $F_{KN} > 0$, and $F_{NK} > 0$.

In equilibrium, profit maximization by competitive firms implies that the wage rate (w) equals the marginal productivity of labor, i.e., $F_N = w$, and the net capital return rate equals the productivity of capital minus the capital tax rate ($T \geq 0$). With capital mobility, net returns on capital are equalized across regions at the economy-wide equilibrium rate $\bar{\rho}$, which can be assumed to be a parameter in the model:

$$F_K - T = \bar{\rho}. \tag{1}$$

Implicitly, this equation determines the equilibrium amount of K as a function of N and T in each region, so that the partial derivatives are $\frac{\partial K}{\partial T} = \frac{1}{F_{KK}} < 0$ and $\frac{\partial K}{\partial N} = -\frac{F_{KN}}{F_{KK}} > 0$. In words, capital moves out when the tax rate rises or when the labor supply is restricted, holding the other factor constant.

Last, the output can be consumed or transformed into the government-provided good (hereafter called a "public good"). To simplify, the marginal rate of transformation (MRT) is assumed to be 1. Thus, if the public good is financed by the capital tax revenue, the amount of public good provided (G) is given by $G = TK$.

2.3 Utility

Each region is populated by households who supply labor where they live, earning the wage w. Residents also own a share of the capital stock (one unit of capital per household, for simplicity). With capital mobility, capital can be invested elsewhere, earning the net return rate $\bar{\rho}$. Households benefit from the locally provided public good, although there is congestion in its use. The utility from the public good is given by the function $v(G, N)$, with $v_G > 0$ and $v_N < 0$.

Population growth increases the costs of living in the region, which is denoted by $c(N)$, with $c_N > 0$. In urban economics models, this increasing cost of living comes first from competition for scarce land (space), which makes land rents to rise with greater population.[5] Second, population growth generates negative externalities (e.g., pollution, loss of open space, or congestion in the use of public goods), reducing the quality of living in the region.[6]

Hence, in a region with wage w, public good provision G, and population N, the utility of a resident is given by $u = w + \bar{\rho} + v(G, N) - c(N)$. This function implies that, holding T and K constant, utility would decrease with greater N as the wage rate decreases while public good congestion and cost of living rise.

With perfect mobility, the population of the region N is such that utility u is equalized everywhere at the economy-wide equilibrium level $\bar{u}$. Hence, the population migration equilibrium condition is:

$$F_N + \bar{\rho} + v(TK, N) - c(N) = \bar{u}, \tag{2}$$

where $w = F_N$ and $G = TK$ were used, and $\bar{\rho}$ is the equilibrium mobile capital return rate in the overall economy. This equation determines the free mobility population, denoted as $\tilde{N}$ hereafter, as an implicit function of K and T.

3 Government policy

3.1 Objective and efficiency of government provision

In this analysis, the government maximizes the aggregate welfare of residents (W) in the region.[7] Hence, given the household's utility function u described before, we have:

$$W = Nu. \tag{3}$$

It is interesting to first notice that the provision of the public good would be socially efficient if production factors were immobile. To verify, note that factor immobility implies

[5]In the standard land use model, households pay for commuting costs and land rents (Brueckner, 1999). As the population grows, more residents compete for land, so that rents rise.

[6]Growth control was first advocated as a way to mitigate the negative environmental externalities from population growth (Fischel, 1990). This is called the "amenity creation" argument in the literature (see Brueckner, 1999).

[7]This objective function simplifies the analysis compared to models with land rents, where the local government typically maximizes total land rents in the region. The results regarding the impact of population control on capital taxation are qualitatively similar regardless of the objective function as long as there is capital flight and congestion in the use of public goods.

$\frac{dK}{dT} = 0$ and $\frac{dN}{dT} = 0$ while the net capital return (ρ) would now be endogenous, directly reduced by the tax amount T, i.e., $\frac{d\rho}{dT} = -1$. Thus, the first order condition (FOC) for the maximization of W with respect to T would be simply $Nv_G = 1$ in a symmetric equilibrium where $K = N$ (that is, with no net capital export or import). In this FOC, the left hand side (LHS) represents the marginal rate of substitution (MRS) between the public and the private good and the right hand side (RHS) is the marginal rate of transformation (MRT). Since MRS=MRT, the chosen G is socially efficient. However, as shown later, capital mobility causes underprovision of the public good, as typically found in tax competition models.

3.2 Tax choice with free population migration

With capital and population mobility, recall that equations (1) and (2) determine the equilibrium K and N. Thus, the regional government maximizes the objective function (3) with respect to T, subject to (1) and (2). Because the utility level of households is determined exogenously by the migration equilibrium in the economy, the objective function becomes simply $W = N\bar{u}$. As a result, the FOC is $\frac{dN}{dT} = 0$.

Total differentiation of the free migration condition (2) implies that $\frac{dN}{dT} = -\frac{du}{dT}/\frac{du}{dN}$. Thus, since $\frac{dN}{dT} = 0$ at the optimal T, the FOC implies $\frac{du}{dT} = 0$, that is:

$$F_{NK}\frac{\partial K}{\partial T} + v_G\left[K + T\frac{\partial K}{\partial T}\right] = 0, \tag{4}$$

where $\frac{dK}{dT}$ was replaced by $\frac{\partial K}{\partial T}$ since they are equal when $\frac{dN}{dT} = 0$ at the optimum. Assuming that the marginal tax revenue is positive (i.e., $K + T\frac{\partial K}{\partial T} > 0$), equation (4) implies that the optimal T is such that the marginal value of an increase in the provision of the public good equals the marginal decrease in the wage rate due to capital loss.[8]

To make it easier to interpret the results, first note that $\frac{\partial K}{\partial T} = \frac{1}{F_{KK}}$ from equation (1), so that the first term in equation (4) becomes $\frac{F_{NK}}{F_{KK}}$. Now, consider the case of a typical CRS Cobb-Douglas production function $F(K, N) = AK^{\alpha}N^{1-\alpha}$, with $A > 0$ and $\alpha \in (0, 1)$. For this case, $\frac{F_{NK}}{F_{KK}} = -\frac{K}{N}$, so that, rearranging terms, equation (4) becomes:

$$Nv_G\left[K + T\frac{\partial K}{\partial T}\right] = K. \tag{5}$$

However, since $K + T\frac{\partial K}{\partial T} < K$, we conclude that $Nv_G > 1$, that is, the MRS of the public good for the private good is greater than the MRT, indicating underprovision of G due to capital flight as expected in a tax competition model.

Next, we look at how population control affects the optimal T.

3.3 Tax choice with population control

In this static model, population control directly restricts the potential population N. The regional government chooses the tax rate T and the population N to maximize the objective function (3) subject to the capital mobility equation (1). Because the utility level

[8]Note that there is no loss of capital income as $\bar{\rho}$ is fixed.

of households is now endogenous, the objective function becomes $W = Nu$, with N being a policy choice variable, so that the resulting FOC for the optimal T is now $N\frac{du}{dT} = 0$, which can be written as $F_{NK}\frac{dK}{dT} + v_G\left[K + T\frac{dK}{dT}\right] = 0$. Since $\frac{dK}{dT} = \frac{\partial K}{\partial T}$ in the controlled case, the FOC for T ends up being the same as in the free migration case presented before, that is, equation (4). However, because N is now chosen by the government instead of being determined by the equilibrium condition (2), the optimal value of T will be different.

Nonetheless, since the FOCs are the same, the optimal T would be the same if the controlled N matched the unrestricted $\tilde{N}$. Since population control is, in practice, a reduction of N, we will then look at the effect of a decrease of N on the optimal T, starting from the original unrestricted $\tilde{N}$. Note that, in this model, the FOC for the optimal N is: $u + N\frac{du}{dN} = 0$. Thus, a controlled $N < \tilde{N}$ happens only if, at the uncontrolled equilibrium, $\frac{du}{dN}$ is significantly negative, that is, only if there were large enough public good congestion (v_N is large) or large enough marginal cost of living (c_N is large). This case, where population control is optimal, will be assumed hereafter.[9]

To analyze how T is affected by population control, it is important to first understand what the FOC for T implies. To make it easier to interpret, consider the CRS Cobb-Douglas case, where the FOC is given by (5). To simplify the notation, denote the marginal tax revenue $\left[K + T\frac{\partial K}{\partial T}\right]$ by Z. Thus, (5) becomes simply $Nv_G Z = K$. The LHS of this equation represents the marginal benefit of taxation (MB_T) while the RHS represents the marginal cost (MC_T). Intuitively, a higher T raises total utility of G by $Nv_G Z$, but reduces income by K. Implicit differentiation of the FOC (5) with respect to T and N implies:

$$\frac{dT}{dN} = -\frac{Nv_{GN}Z + NZv_{GG}T\frac{dK}{dN} + Nv_G\frac{dZ}{dN}}{Nv_{GG}Z^2 + Nv_G\frac{dZ}{dT} - \frac{dK}{dT}}, \tag{6}$$

where the denominator is negative if the SOC for T is satisfied. Thus, the effect of a reduction of N on the optimal T depends on the sign of the numerator, which has three terms:[10]

- Congestion effect: the first term in the numerator (where $v_{GN} < 0$) indicates that population control reduces congestion, thus raising the MB_T.
- Marginal utility (v_G) effect: in the second term, $T\frac{dK}{dN} > 0$ implies that population control causes a tax revenue loss, so that v_G rises (as $v_{GG} < 0$), thus raising the MB_T.
- Marginal tax revenue (Z) effect: in the third term, since $\frac{dZ}{dN} > 0$ for a CRS Cobb-Douglas production function, population control reduces Z, thus decreasing the MB_T.

Therefore, population control has ambiguous effects on the desirability of capital taxation: on one hand, it reduces congestion in the use of the public good and reduces G, raising its marginal utility, but on the other hand, it reduces the marginal tax revenue Z.

To better understand this ambiguity, consider the special utility function case where $v(G, N) = \phi G^a N^{-b}$, with $\phi > 0$, $a \in (0, 1)$, and $b \in [0, 1]$. Here, a higher b indicates greater

[9] Although, as mentioned before, governments may restrict population migration for other reasons, for instance, hostility to immigrants due to fear of increased job competition or crime, and ethnic discrimination.

[10] The numerator in the RHS of (6) has two other hidden terms: $v_G Z$ and K/N, but they cancel each other out at the optimal T since the FOC (5) can be rewritten as $v_G Z = K/N$.

congestion in the use of the public good ($b = 0$ implies a pure public good, while $b = 1$ implies a government-provided private good).

First, with a CRS Cobb-Douglas production function, $\frac{dK}{dN} = \frac{K}{N}$ and $\frac{dZ}{dN} = \frac{Z}{N}$, so the numerator in (6) can be rewritten as $Nv_{GN}Z + v_{GG}ZG + v_G Z$. With the special $v(G,N)$ function adopted above, the second and third terms of the numerator become together $a^2\phi G^{a-1}N^{-b}Z > 0$, indicating that the capital flight effect of population control (represented by those two terms) induces a tax rate reduction. However, adding back the congestion effect (the first term) yields a total effect of $(a-b)\,a\phi G^{a-1}N^{-b}Z$, which is positive when $a > b$. Hence, population control induces a lower T only if the public good congestion parameter (b) is small enough. Otherwise, if congestion is large enough ($b > a$), the marginal reduction in congestion caused by population control induces a higher optimal T.

In general, since the analysis above only applies to a change in taxation from the initial optimal when population was $\tilde{N}$, it is possible that the effect of population control on the optimal T changes direction as control becomes stricter. Therefore, it can only be concluded that the direction of the change in taxation is ambiguous, depending on how population control affects capital flight and the congestion in the use of the government-provided good.

3.4 Numerical Analysis

To illustrate the theoretical results, a numerical example can be created using the model setup above. For this exercise, the model parameters make population control to be desirable, that is, population growth is costly enough to society to make the government want to control it. In the CRS Cobb-Douglas production function, $A = 1$ and $\alpha = 0.5$. In the special case public good utility function ($v(G,N) = \phi G^a N^{-b}$), $\phi = 0.25$, $a = 0.4$, and b is made to vary from 0 (the pure public good case) to 1 (the government-provided private good case). The increasing cost of living function is assumed to be linear, given by $c(N) = 0.04N$.

To find the optimal T, note that in a symmetric economy-wide equilibrium, N is the same everywhere, equaling the total population divided by the number of regions. The amount of capital is also equally shared, with one unit of capital per household, so $K = N$ in the symmetric equilibrium. Each region was assumed to have $\tilde{N} = 25$ in equilibrium. This equilibrium allocation of resources determines the equalized net capital return $\bar{\rho}$ and equalized utility $\bar{u}$ according to equations (1) and (2) respectively. However, in the population control case, a symmetric equilibrium with all regions adopting control implies that some people must be displaced to new regions, which would also adopt control.

Table 1 presents the results. The second column shows the tax rate choice under unrestricted population while the fourth column shows the T under symmetric control.

In Table 1, note that a higher value of b results in a lower optimal T as there is more congestion in the use of the public good. But because population control reduces this potential congestion, when b is high, the optimal T is greater under population control than under free migration, despite the capital loss caused by the control. On the contrary, if b is small (congestion is less relevant), the capital flight effect of population control induces a lower T than under free migration.[11]

[11] As an alternative to the symmetric control case, it is worth considering the possibility that only one region adopts control as others might be politically constrained, e.g., due to agreements with other governments in a federation or union. If the controlling jurisdiction is small, unilateral changes in T and N will

Table 1: Capital taxation with population control - numerical example

	free mobility:		symmetric control:	
b	T	$\tilde{N}$	T	N
0	0.250	25.0	0.208	19.0
0.2	0.085	25.0	0.071	14.3
0.4	0.029	25.0	0.029	13.0
0.6	0.010	25.0	0.013	12.7
0.8	0.003	25.0	0.005	12.5
1	0.001	25.0	0.002	12.5

The utility of the public good is given by $v(G, N) = \phi G^a N^{-b}$, with $\phi = 0.25$ and $a = 0.4$. When $b < a$, population control induces a lower optimal T, but the opposite happens when $b > a$.

4 Conclusions

This paper studies how population growth controls impact the taxation of mobile capital. Concerns about excessive population or hostility against immigrants has led to the adoption of population control measures, e.g., housing regulations or restrictive immigration laws. As labor supply growth becomes constrained by such measures, lower taxation may be advocated to avoid capital flight. However, population control also reduces the potential congestion in the use of government-provided goods, making taxation to be marginally more beneficial. Hence, population control may lead to greater tax rates when there is significant marginal congestion in the use of government-provided goods.

For instance, advocates of strict housing regulations often claim that local government services and infrastructure are subject to increasing congestion, in which case the marginal benefit of taxation would be greater under population control, potentially leading to higher tax rates. While no empirical study has been done on the relationship between capital taxation and population control, an analysis of strategic tax competition by Brueckner and Saavedra (2001) found that municipalities in Massachusetts with lower population growth had higher property tax rates, although congestion in the use of government services was not accounted for.

The model presented here ignores several characteristics of real-world economies that might affect capital taxation, including agglomeration economies, regional asymmetries, the residence of capital owners, or a different government objective function (perhaps privileging tax revenue collection or income redistribution). Such factors are unlikely to change the qualitative results regarding the effects of population control on capital taxation when there is congestion in the use of public goods. However, in future research, it would be interesting to look at how population control affects other tax bases, e.g., land, income, or consumption, as the resulting increase in land prices and wages may allow for lower tax rates.

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not affect $\bar{\rho}$, giving the controlling region the ability to attract capital more easily since it is the only one lowering taxes (something unlikely in a symmetric equilibrium, where all regions change taxes). Hence, if b is small (so that a lower T is optimal), the controlled region could end up with a much lower T, resulting in a much higher K despite the lower N, depending on the parameters of the model. This extreme scenario may be unrealistic in the long term, but it provides an idea of what a government might be willing to try in the short term if it is the first to enact stricter population control.

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