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Bureaucrats and Tax Limitation*

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This paper examines the welfare effect of tax limitation and the nature of voting equilibrium on tax limitation proposals in an economy where voters initially accept or reject the tax bill proposed by a monopoly bureau. Since tax limitation enables voters to limit the tax bill to the desired level, it improves the voters' welfare. However, voters may not impose tax limitation, because the bureau may prevent tax limitation ahead of time by softening its monopoly position and because heterogeneous voters may fail to agree on how much the tax should be limited. The analysis attempts to identify the conditions under which voters impose tax limitation. © 1993 Academic Press, Inc.

1. INTRODUCTION

Since the passage of California's Proposition 13 in 1978, voters in many states have imposed limitations on their governments' power of taxation. One of the reasons for this recent movement is that the public sector budget does not reflect the wishes of voters.[1] As is discussed in the public choice literature, such as Niskanen [13], the bureau controls the tax bill and quantity of public output to pursue its own goals. In particular, the bureau makes the tax bill excessive relative to the level desired by voters. Given this undesirable bureaucracy, viewing tax limitation as a means of controlling the bureau directly by voters, this paper analyzes the welfare effect of tax limitation and the nature of voting equilibrium on tax limitation proposals.[2]

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[1]Another more specific reason is that, given that many limitations have been imposed on the property tax, voters may simply want to shift taxes away from the property tax to state sales and income taxes.

[2]In the literature on tax limitation, among many others, Ladd [7], Courant and Rubinfeld [2], and Inman [6] analyze the welfare effect of tax limitation. Shapiro and Sonstelie [16] test the two competing models, the median voter paradigm and the Leviathan view, based on the actual responses of California voters in 1978. In addition to individual papers, the supplement issue of the 1979 *National Tax Journal* [11] and the book edited by Ladd and Tideman [8] contain various papers concerning tax limitation.

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In modeling the bureau's behavior, many researchers have extended the simple budget-maximizing model by including managerial slack as another argument in the bureau's utility function (see, for example, Migue and Belanger [9], Niskanen [14], and Moene [10]). Along this line of extension, the bureau in this paper has an interest in a large budget or tax bill as well as a low effort level, which may be interpreted as slack. Low effort raises the cost of a public good, making voters worse off. Thus, one can think of the voter–bureau relationship as a principal–agent relationship in that the bureau's effort affects not only the bureau but also the voters. In this view simple tax limitation cannot be an effective measure of controlling the bureau, because it does not control effort.

In the model, as in Romer and Rosenthal [15], voters initially only accept or reject the tax bill proposed by the bureau, which sets the agenda in a referendum. This budgetary process enables the bureau to manipulate the agenda so that voters are forced to accept a tax bill larger than the efficient level, given that the bureau derives satisfaction from a large tax bill. This justifies tax limitation that allows voters to limit the excessive tax bill to the level they desire. However, the self-interested bureau decreases its effort level in response to tax limitation, causing the cost of the public good to rise. Thus, while the welfare effect of tax limitation depends on these benefits and costs, tax limitation is shown to improve the voters' welfare if appropriately imposed.

That tax limitation improves the voters' welfare does not lead to the conclusion that voters will impose tax limitation. This is because the rational bureau may not simply propose the excessive tax bill on which voters will impose a limitation. That is, the bureau may prevent tax limitation ahead of time by proposing a new tax bill and by choosing the effort level appropriately so that voters are indifferent between the new tax bill proposed by the bureau and the tax bill limited by voters. On the other hand, by doing so, the tax-maximizing bureau is worse off than with the original excessive tax bill, but better off than with the limited tax bill, because the new tax bill is still greater, due to a higher effort, than the limited tax bill. Thus, given that tax limitation as a constitutional change continues to be effective from the next period on, once imposed at the current period, prevention makes the bureau better off from the next period on, because it is better off with the new tax bill than with the limited tax bill. However, prevention makes the bureau worse off in the current period, because it has to sacrifice the original excessive tax bill and propose the new tax bill in order to prevent tax limitation. Therefore, if the bureau is patient enough to highly evaluate the long-run gain from preventing tax limitation, then the bureau would prevent, and voters would not impose tax limitation.

Extending the analysis to the case with heterogeneous voters enables us to discuss voting equilibrium on tax limitation and its distributive conse-

quences. Although a majority benefits to some extent from tax limitation, heterogeneous voters may fail to reach an agreement on how much the current tax bill should be limited. The reason is that, for any small limitation close to the status quo, voters are worse off than under the status quo due to the decreased effort level, while there is little gain from a reduction in the bureau's excessive tax bill. Thus, voters' preferences for tax limitation are discontinuous and not single peaked at the status quo, and voting equilibrium may not exist because of the well-known cyclical majority problem.

Tax limitation, if a voting equilibrium exists, limits the tax bill to some degree and hence favors lower demanders of the public good provided that the cost of the public good is equally shared. Since tax limitation occurs when the bureau is impatient, the impatient bureau makes those lower demanders better off. Thus, if the poor are lower demanders, the impatient bureau would bring a more equitable outcome than the patient bureau. Otherwise, the opposite holds.

The plan of the paper is as follows. The next section presents the model. Section 3 analyzes the benefits and costs of tax limitation and shows that tax limitation improves the voters' welfare by limiting the bureau's excessive tax bill appropriately. Section 4 considers the possibility that the bureau prevents tax limitation. Section 5 discusses voting equilibrium on tax limitation and its distributive consequences, and Section 6 gives a conclusion.

2. THE MODEL

In an economy with identical voters, the representative voter's preferences are given by the strictly quasi-concave utility function

$$U[x, z], \tag{1}$$

where x is a composite private good whose price is normalized to one, and z is a public good.

The cost of providing the public good is $C(z, e)$, with $e \in [\underline{e}, \bar{e}]$ denoting the bureau's effort level. For analytical convenience, rewrite the cost as

$$C(z, e) = zc(e), \tag{2}$$

where $c(e)$ is then the unit cost or the price of the public good, with $c(e)$ decreasing and convex. The cost function means that the bureau can control the cost of the public good by changing its effort level. Since the bureau's effort plays an important role in the subsequent analysis, it is discussed more below, together with the bureau's utility function.

Assuming that the cost of the public good is equally shared among voters, the voter's budget constraint is

$$I = x + t/n, \tag{3}$$

where $t = zc(e)$ is the total tax bill, I is income, and n is the number of voters in the economy. Substituting (3) into (1) and using the fact that $z = t/c(e)$, we write the utility function in terms of t and e as

$$V(t, e) \equiv U[I - t/n, t/c(e)]. \tag{4}$$

To avoid uninteresting cases, assume that there is an interior value of $t \in (0, nI)$ that maximizes $V(t, e)$ for any given $e \in [\underline{e}, \bar{e}]$. Since the function $V(t, e)$ is frequently used below, let us list the properties of $V(t, e)$ without proof as follows:

Properties of $V(t, e)$. (i) $V(t, e)$ is single peaked in t.
(ii) $V_t(0, e) > 0$ and $V_t(nI, e) < 0$ for all e.
(iii) $c'(e) < 0 \Rightarrow V_e(t, e) = -tc'(e)U_z[I - t/n, t/c(e)]/c(e)^2 > 0$ for $t > 0$.
(iv) $V_e(0, e) = 0$ for all e.

Property (i) directly follows from strict quasi-concavity of the utility function and convexity of the budget constraint. Property (ii) means that the peak point of $V(t, e)$ is at some positive t between 0 and nI, with subscripts denoting partial derivatives, which follows from the interior solution assumption above. Property (iii) says that voter's utility increases in the bureau's effort level. Property (iv) follows from the definition of $V(0, e) = U[I, 0]$, meaning that e does not affect voter's utility if no public good is provided. Thus, henceforth we write $V(0)$ for $V(0, e)$ for all e. Using the properties of $V(t, e)$, Fig. 1 shows a map of $V(t, e)$, where

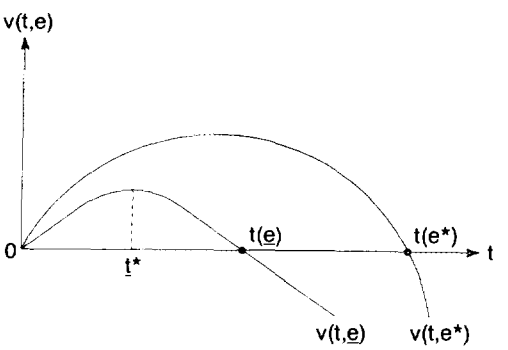

FIGURE 1

$e^* > \underline{e}$. In the figure, the curve $V(t, e^*)$ is above the curve $V(t, \underline{e})$ everywhere except at $t = 0$ from Properties (iii) and (iv).

On the supply side of the public good, following the public choice literature,[3] the bureau controls the public good level and tax bill to pursue its own goal rather than passively fulfill the desires of voters, as posited in the traditional median voter paradigm (see Bowen [1] and Downs [4]). The bureau is assumed to have preferences over the tax bill and effort given by the strictly quasi-concave utility function

$$B[t, e], \tag{5}$$

where $B[t, e]$ increases in t and decreases in e.

Effort, e, may be interpreted in various ways. First, since a low effort means a high unit cost of the public good, it can be interpreted as waste and slack enjoyed by the bureau. This is exactly how many researchers have extended the simple budget-maximizing model to a more sophisticated bureau. For example,[4] Moene [10] assumes that the bureau has positive marginal utility of the output level and of the budgetary slack, defined as the difference between appropriate budget and true minimum costs of producing the public good. Our model is consistent with that of Moene, because the budgetary slack is nothing but $c(e)z - c(\bar{e})z$.

Second, more generally, effort represents anything that the bureau controls but that affects both voters and the bureau. For instance, assume that the bureau prefers a large tax bill as well as a higher labor–capital ratio in the production of the public good, because the bureau may enjoy more power from controlling more subordinates and because bureaucrats themselves are interested in securing their jobs. Then, as the labor–capital ratio rises, the bureau is better off, but voters are worse off. This is because the cost of the public good rises due to the technological inefficiency associated with the inappropriate combination of the production factors.[5] In this case, a low effort in the model may be interpreted as a higher labor–capital ratio.

As a related point, let us compare our model with the principal–agent model (for example, Holmstrom [5]). First, there are some similarities between the two models in that voters (principal) and the bureau (agent) have conflicting interests in the level of effort. That is, a low level of effort exerted by the bureau makes the bureau better off, but makes voters worse off as indicated in Property (iii) of $V(t, e)$. Second, the difference lies in

[3]For example, see Niskanen [12–14], Romer and Rosenthal [15], and Moene [10].

[4]See also Migue and Belanger [9] and Niskanen [14].

[5]An earlier version of this paper analyzes the welfare effect of tax limitation under the assumption that the bureau's utility increases in the tax bill as well as in the labor–capital ratio.

the absence of moral hazard. In the principal–agent literature, the principal cannot observe the agent's effort level due to uncertainty, leading to an inefficient allocation of resources (namely a moral hazard problem). On the other hand, in our model there is no uncertainty, and the bureau's effort level can be inferred, through the relationship $t = zc(e)$, from the level of public output and the tax bill, which may be observable. Thus, while there is no moral hazard problem in this paper, tax limitation does not lead to a first-best outcome. This is because tax limitation does not control effort or output, but simply limits the excessive tax bill. The inefficiency here stems from lack of appropriate mechanisms to control the agent, while it comes from unobservability of effort in the principal–agent problem. However, as is discussed in the next section, tax limitation improves to some extent the voters' welfare.

3. WELFARE EFFECT OF TAX LIMITATION

To analyze the effect of tax limitation, it is necessary to describe how the tax bill is determined in the absence of tax limitation. As in Romer and Rosenthal [15], voters are initially supposed to accept or reject the tax bill that the bureau proposes in a referendum. If it is rejected, the tax bill will be set at a predetermined reversion tax bill. Since voters accept the tax bill only if it makes them no worse off than the reversion tax bill, the bureau will propose a tax bill by choosing t and e to maximize its utility $B[t, e]$ subject to

$$V(t, e) \geq V(0) = V(0, e), \tag{6}$$

where the reversion tax bill is assumed to be zero (the nonzero reversion tax case is discussed below). Here, we assume that voters prefer the bureau's tax bill t to the reversion tax when $V(t, e) = V(0)$, which is never crucial, but is convenient in the analysis below.

Given that $V(t, e)$ is single peaked in t from Property (i), there are two t's corresponding to a utility level $V(t, e)$ for given e, and the tax-maximizing bureau will always choose the larger t on the right-hand side of the peak point of $V(t, e)$. This means that constraint (6) is binding at the solution, and it is convenient to consider the bureau's problem as a two-stage maximization problem. First, from the observation that constraint (6) is binding, the bureau's tax bill for given e, denoted $t(e)$, satisfies the equation

$$V(t, e) = U[I - t/n, t/c(e)] = V(0) = U[I, 0]. \tag{7}$$

It is geometrically evident that $t(e)$ is the tax bill, for any given e, where the curve $V(t, e)$ cuts the abscissa (t-axis), as shown in Fig. 1. Second, the

bureau will choose effort to maximize $B[t(e), e]$. Note that while the choice of e affects the bureau, it does not affect voters. The reason is that the bureau chooses the tax bill $t(e)$ for any given e so that voters are indifferent between the zero reversion tax and $t(e)$.

Before we find the optimal effort for the bureau, it is useful to consider the relationship between the tax bill $t(e)$ and effort. Interpreting $c(e)$ as the price of the public good and z as the quanity demanded for the public good, the tax bill $t(e)$ is the total expenditure on z or the revenue for the monopolist, and it normally increases or decreases in e, depending on whether the price elasticity of z is greater or less than 1. However, the demand for the public good, $z(e) = t/c(e)$, is not a regular demand in that it is not derived from the voters' utility maximization, but is chosen by the tax-maximizing bureau. This demand turns out to be always elastic, and the tax bill $t(e)$ always increases in e. That is, totally differentiating constraint (7) and rearranging terms yield

$$t'(e) = t(e)c'(e)U_z[\cdot]/[U_z[\cdot]/c(e) - U_x[\cdot]/n]c(e)^2 > 0, \quad (8)$$

because the bureau chooses t on the right-hand side of the peak point of $V(t, e)$ and because the denominator, $V_t(t, e)$, is negative.

Returning to the bureau's choice of effort, the necessary condition for an optimal e, denoted e^*, is

$$B_t[\cdot]t'(e) + B_e[\cdot] = 0, \quad (9)$$

where an interior solution is assumed to exist. Equation (9) means that the marginal cost (disutility) of making an extra effort should be equal to the marginal gain from an increase in the tax bill. Put differently, the bureau has an incentive to provide the public good somewhat efficiently (at a lower cost) by making efforts in order to induce voters to buy a large tax bill. This means that tax limitation is potentially harmful, because it reduces the bureau's incentive to do so, as is discussed below.

Now, consider possible tax limitation that enables voters to limit the bureau's tax bill to a level of tax, denoted $\underline{t}$. Thus, the essence of tax limitation is that voters choose the tax bill rather than simply accepting or rejecting the tax bill proposed by the bureau. Given that the tax-maximizing bureau proposed an excessive tax bill, $t(e^*)$, voters will limit the tax bill to

$$0 \leq \underline{t} \leq t(e^*), \quad (10)$$

where $t(e^*)$ is called "the status quo" and is assumed to be less than nI. To analyze the welfare effect of tax limitation, note first that the bureau

will minimize effort to maximize its utility $B[\underline{t}, e]$, for a given $\underline{t}$, in response to tax limitation.[6] Then, since the minimum effort is $\underline{e}$,[7] the representative voter's utility is

$$V(\underline{t}, \underline{e}) = U\left[I - \underline{t}/n, \underline{t}/c(\underline{e})\right]. \tag{11}$$

Thus, the benefit of tax limitation is a reduction in the bureau's excessive tax bill, while the cost is an increase in the unit cost of the public good resulting from the decreased effort. Geometrically speaking, in Fig. 1 tax limitation moves voters from the point $t(e^*)$ on the higher curve $V(t, e^*)$ to any point on the lower curve $V(t, \underline{e})$, implying that tax limitation allows voters to choose the tax bill according to their preferences, but at a higher cost. Therefore, whether tax limitation improves the voters' welfare depends on the benefit and cost involved in tax limitation. However, in the model, tax limitation makes voters better off if the tax bill is appropriately chosen. The reason is that $V(t, \underline{e})$ is increasing in t at $t = 0$ from Property (ii). Therefore, voters always can improve the welfare achievable under the status quo by choosing a tax bill close to zero, even if the unit cost of the public good becomes higher due to the decreased effort. In particular, it is evident in Fig. 1 that tax limitation is welfare improving if the tax bill is limited to $\underline{t} \in (0, t(\underline{e}))$.

On the other hand, tax limitation makes the bureau worse off, because voters limit the bureau's utility-maximizing tax bill. That is,

$$B[t(e^*), e^*] > B[t(\underline{e}), \underline{e}] > B[\underline{t}, \underline{e}] \qquad \text{for } \underline{t} \in (0, t(\underline{e})), \tag{12}$$

where the first inequality comes from the definition of e^* and the second one from the assumption that the bureau's utility increases in the tax bill. We summarize this as follows:

PROPOSITION 1. *If $\underline{t} \in (0, t(\underline{e}))$, tax limitation makes voters better off, but the bureau worse off.*

[6] While the minimum effort is a bureau's reasonable reaction to tax limitation, the bureau's reaction in general depends on how the bureau's utility function is specified. For instance, if the bureau's utility function were $B[z, e]$ rather than $B[t, e]$, then the bureau would choose the effort level to maximize $B[\underline{t}/c(e), e]$ for a given $\underline{t}$. In this case, tax limitation lowers the bureau's marginal benefit from making effort, and the bureau decreases effort. On the other hand, as tax limitation decreases the level of public output for a given amount of effort, the bureau may increase effort in order to compensate for the utility loss due to the lower output. These are usual substitution and income effects, and the effect of tax limitation on the bureau's effort level cannot be determined.

[7] The minimum effort level, $\underline{e}$, may be determined by a legal and political condition. For instance, the bureau should work 40 hours per week. However, the size of $\underline{e}$ is never important. All that is needed is that the bureau reduce the effort level, in response to tax limitation, relative to the status quo ($\underline{e} < e^*$). For further discussion of $\underline{e}$, see footnote 8.

An implication of the proposition is that, to improve the voters' welfare, tax limitation must involve a severe departure from the status quo. This is because the bureau decreases the effort in response to tax limitation and because a large reduction in the tax bill is needed to compensate for the welfare loss from the decreased effort.[8]

To see the role of the zero reversion tax bill in the analysis above, suppose that the reversion tax bill is $t_r > 0$. Then, as in the zero reversion tax case in (6), the bureau's problem is to choose t and e to maximize $B[t, e]$ subject to

$$V(t, e) \geq V(t_r, \underline{e}), \tag{13}$$

where it should be noted that the bureau will minimize the effort level when its tax bill is rejected (and the tax bill is set at the reversion level), as it did in response to tax limitation. Since constraint (13) holds as an equality at the solution, voters enjoy the utility $V(t_r, \underline{e})$ in the absence of tax limitation. Then, whether tax limitation improves the voters' welfare depends on whether $V(\underline{t}, \underline{e}) > (<) V(t_r, \underline{e})$. Since tax limitation enables voters to choose the tax bill that they desire, and since the unit cost of the public good is the same due to the same effort level, $\underline{e}$, tax limitation makes voters better off if the tax bill is appropriately chosen.[9] Thus, the nonzero reversion tax does not change the essentials of the analysis.

4. BUREAU'S PREVENTION OF TAX LIMITATION

The upshot emerging from the above discussion is that voters will impose a limitation on the tax bill that the utility-maximizing bureau proposes. However, this is not a useful prediction, because tax limitation makes the bureau worse off and because the rational bureau would not propose the tax bill on which voters impose a limitation. That is, since the bureau is long lived, and since tax limitation is viewed as a constitutional change in that it continues to be effective once imposed unless voters lift it again,[10] the bureau will consider the long-run effect in proposing the tax bill to voters. In particular, the bureau may prevent tax limitation ahead of

[8]The proposition hinges on the fact that $V(t, e)$ is increasing in t at $t = 0$ for any given $e \in [\underline{e}, \bar{e}]$ from property (ii). However, as a referee has pointed out, if $\underline{e}$ is sufficiently low or the price of the public good is sufficiently high, voters may be better off without any public good or tax and $V(t, \underline{e})$ may be decreasing in t at $t = 0$. Thus, if this is the case, the proposition needs an additional assumption that $\underline{e} > \hat{e}$, where $\hat{e}$ is the critical value of $\underline{e}$, above which $V(t, \underline{e})$ is increasing in t at $t = 0$.

[9]However, it is clear that if the reversion tax bill t_r is incidentally $\underline{t}^*$ in Fig. 1, then tax limitation cannot make voters strictly better off.

[10]This view conforms to real world tax limitations such as California's Proposition 13 and Michigan's Headlee Amendment.

time by softening its monopoly position, because otherwise voters would immediately impose tax limitation by Proposition 1 and because tax limitation makes the bureau worse off. Thus, even if tax limitation improves the voters' welfare, as discussed in the previous section, it does not follow that voters will impose tax limitation.[11]

Consider the bureau's decision at period q whether to prevent tax limitation. While q can be any period, for the sake of concreteness let q be the current period (that is, $q = 0$). Suppose first that the bureau decides not to prevent and proposes the tax bill, $t(e^*)$. Then, given that tax limitation makes voters better off by Proposition 1 for $\underline{t} \in (0, t(\underline{e}))$, rational voters will impose a limitation that limits the bureau's tax bill to the most preferred level, denoted $\underline{t}^*$. Note that $\underline{t}^*$ is the tax bill corresponding to the peak point of the curve $V(t, \underline{e})$ in Fig. 1. Tax limitation will be effective from the next period on, and the bureau's lifetime utility will be[12, 13]

$$B[t(e^*), e^*] + \sum_{i=1}^{\infty} \delta^i B[\underline{t}^*, \underline{e}], \tag{14}$$

where $\delta \in (0, 1)$ is the bureau's discount factor.

On the other hand, if the bureau attempts to prevent tax limitation, the bureau should propose a tax bill that makes voters no worse off than $\underline{t}^*$. Thus, the bureau will choose t and e to maximize $B[t, e]$ subject to $V(t, e) \geq V(\underline{t}^*, \underline{e})$. Since the constraint is again binding at the solution, let $t_a(e)$ be the tax bill for given e satisfying the constraint as an equality. Then, the bureau will choose the effort level, denoted e_a, that maximizes

[11] There is yet another reason why voters may not impose tax limitation even if it is welfare improving. Tax limitation may be interpreted as a means of shifting the decision-making power from the bureau to voters in the sense that voters themselves form the agenda rather than simply accepting or rejecting the bureau's tax bill. Thus, tax limitation involves a transactions cost in terms of time and effort on the part of voters. This consideration would not only reduce the voters' welfare when they impose tax limitation, but also raise a free-rider problem. While the discussion of this point may be useful, it is too simple to add any insight in the case of homogeneous voters and is too complicated to derive any meaningful result in the case of heterogeneous voters. Because of this, we omit this issue here. Instead, the final section discusses briefly a possible outcome when the transactions cost and free-rider problems are considered. Denzau *et al.* [13] consider this issue in a different model with three types of voters.

[12] The bureau as an organization is assumed to live infinitely.

[13] While the bureau considers the lifetime utility in deciding whether to prevent tax limitation, voters do not in imposing tax limitation. This asymmetry does not mean that voters are myopic. Instead, the voters' decision to impose tax limitation in any period is reversible in the future, because voters can impose tax limitation and lift imposition any time. Thus, voters need not consider the lifetime utility.

$B[t_a(e), e]$, and will propose the tax bill $t_a(e_a)$. In this case, the lifetime utility will be

$$\sum_{i=0}^{\infty} \delta^i B[t_a(e_a), e_a]. \tag{15}$$

The net gain from preventing tax limitation is found by subtracting (14) from (15), which is

$$\begin{aligned}\sum_{i=0}^{\infty} \delta^i B[t_a(e_a), e_a] - B[t(e^*), e^*] - \sum_{i=1}^{\infty} \delta^i B[\underline{t}^*, \underline{e}] \\ = \{B[t_a(e_a), e_a] - B[t(e^*), e^*]\} \\ + \sum_{i=1}^{\infty} \delta^i \{B[t_a(e_a), e_a] - B[\underline{t}^*, \underline{e}]\}.\end{aligned} \tag{16}$$

To determine the sign of (16), note first that $t_a(e) < t(e)$ for any e, because $V(t_a(e), e) = V(\underline{t}^*, \underline{e}) > V(t(e), e) = V(0)$. Then, given that the bureau's utility increases in the tax bill, the first bracketed term on the right-hand side of (16) is negative. That is,

$$B[t(e^*), e^*] \geq B[t(e_a), e_a] > B[t_a(e_a), e_a], \tag{17}$$

where the first inequality follows from the definition of e^* and the second from the fact that $t_a(e) < t(e)$ for any e. On the other hand, it follows from the definition of $t_a(e)$ that $t_a(\underline{e}) = \underline{t}^*$. Thus,

$$B[t_a(e_a), e_a] > B[t_a(\underline{e}), \underline{e}] = B[\underline{t}^*, \underline{e}],$$

and hence the second bracketed term in (16) is positive, making the overall sign of (16) ambiguous.

However, since the second bracketed term becomes infinity (zero) as δ approaches one (zero), there exists a critical value of the discount factor, denoted δ^*, such that the net gain is positive (negative) for $\delta > (<)\delta^*$. Intuitively, when the bureau is patient ($\delta > \delta^*$), the bureau enjoys the long-run gain from preventing tax limitation, the second bracketed term in (16), while suffering little from the short-run loss from doing so, the first bracketed term in (16). Therefore, the patient bureau will prevent tax

limitation. An analogous explanation applies to the case when the bureau is impatient ($\delta < \delta^*$), and we state this as[14]

PROPOSITION 2. (i) *If* $\delta \in (0, \delta^*)$, *the bureau proposes the tax bill* $t(e^*)$, *and there will be immediate tax limitation that limits the tax bill to* $\underline{t}^*$.

(ii) *If* $\delta \in (\delta^*, 1)$, *the bureau proposes the tax bill* $t_a(e_a) > \underline{t}^*$, *and there will be no tax limitation.*

While the decision whether to prevent tax limitation depends on how patient the bureau is, voters are better off when the bureau is patient (prevents tax limitation) than when it is impatient (does not prevent). This is because tax limitation at the current period will be effective from the next period on. That is, voters enjoy the same utility level from the next period on regardless of whether the bureau prevents tax limitation, because $V(t_a(e_a), e_a) = V(\underline{t}^*, \underline{e})$ by the definition of $t_a(e)$. On the other hand, in the current period voters enjoy a greater utility when the bureau prevents than when the bureau does not prevent, because $V(t_a(e_a), e_a) = V(\underline{t}^*, \underline{e}) > V(t(e^*), e^*) = V(0)$.

5. HETEROGENEOUS VOTERS AND VOTING ON TAX LIMITATION

Since the degree of tax limitation is determined in a referendum by voting, let us discuss voting equilibrium on tax limitation. Although tax limitation, if the tax bill is appropriately limited or chosen, improves the voters' welfare in an economy with identical voters, heterogeneous voters may fail to reach an agreement on how much the current tax should be limited. It is shown that voting equilibrium on tax limitation may not exist, because voter preferences for tax limitation are not single peaked.

The economy consists of $n = 2k - 1$ voters who differ only in their income, where k is a positive integer. The utility function for voter α is

$$V(t, e, \alpha) \equiv U[I(\alpha) - t/n, t/c(e)], \tag{18}$$

[14]If the tax limitation issue were suitably modeled as a game between voters and the bureau, the game would be a supergame and the equilibrium concept would be a perfect equilibrium. As is well known in the supergame literature, there are multiple equilibria if the discount factor is large. In particular, in equilibrium to prevent tax limitation the bureau may propose any tax bill, denoted $\tilde{t}(e)$, that satisfies $V(\tilde{t}(e), e) \geq V(\underline{t}^*, \underline{e})$ and $B[\tilde{t}(e), e] \geq B[\underline{t}^*, \underline{e}]$ with at least one inequality holding strictly, where e is chosen appropriately by the bureau. In this paper, a tax bill $t_a(e_a)$ is chosen as equilibrium, under which the first constraint holds as an equality (makes voters as well off as under tax limitation) and the second one as a strict inequality (makes the bureau better off than under tax limitation).

where $I(\alpha)$ is voter α's income with $I(\alpha)$ increasing in α, and the cost of the public good is equally shared.[15]

In the absence of tax limitation, the bureau should propose the tax bill that makes a majority of voters no worse off than the reversion tax bill. Thus, the bureau will choose t and e to maximize $B[t, e]$ subject to $V(t, e, \alpha) \geq V(0, \alpha)$ for a majority. Since the constraint is binding at the solution, let $t(e, \alpha)$ for given e and for voter α satisfy

$$V(t, e, \alpha) = V(0, \alpha). \tag{19}$$

The bureau will then choose the median, denoted $t(e, \alpha^*(e))$, of $t(e, \alpha)$ values for given e, because of the reasons that are explained below. By construction, there are $k - 1$ voters whose $t(e, \alpha)$ is less than $t(e, \alpha^*(e))$ and another $k - 1$ voters whose $t(e, \alpha)$ is greater than $t(e, \alpha^*(e))$. Let F (S) be a set of voters who are in the first (second) group. Then,

$$V(t(e, \alpha^*(e)), e, \alpha) > (<) V(t(e, \alpha), e, \alpha) = V(0, \alpha) \quad \text{for } \alpha \in S\ (F), \tag{20}$$

meaning that voters in S (F) are better (worse) off with the bureau's tax bill than with the zero reversion tax. This implies that the bureau's tax bill is $t(e, \alpha^*(e))$ for given e, as claimed above, because it makes a majority, voters $\alpha^*(e)$ and $\alpha \in S$, at least as well off as does the reversion tax. Then, the bureau will choose the effort level, denoted e^{**}, that maximizes its utility $B[t(e, \alpha^*(e)), e]$ and propose the tax bill $t(e^{**}, \alpha^*(e^{**}))$. Note that in choosing effort the bureau takes into account its effect on the value of α^*.

Now, consider tax limitation that limits the tax bill to $\underline{t} \leq t(e^{**}, \alpha^*)$, where for notational simplicity we write α^* for $\alpha^*(e^{**})$. Since each voter imposes a limitation or chooses a tax bill that most improves his utility when voting, define the net benefit or improvement in utility, from imposing a limitation that limits the tax bill to $\underline{t}$, for voter α as

$$g(\underline{t}, \alpha) \equiv \begin{cases} V(\underline{t}, \underline{e}, \alpha) - V(t(e^{**}, \alpha^*), e^{**}, \alpha) & \text{when } \underline{t} < t(e^{**}, \alpha^*) \\ 0 & \text{when } \underline{t} = t(e^{**}, \alpha^*), \end{cases} \tag{21}$$

where $g(t(e^{**}, \alpha^*), \alpha) = 0$ by the definition of the status quo. For future

[15] If the public good is financed by a proportional income tax, Proposition 3 remains intact. However, with the additional assumption that $f(x) = x$, Proposition 4 still holds and a result opposite to that of Proposition 5 holds (see the explanation following Proposition 5).

reference, call $\underline{t}^*(\alpha)$ the most preferred $\underline{t}$ for voter α such that $\underline{t}^*(\alpha) \equiv \arg\max g(\underline{t}, \alpha)$. Note that $\underline{t}^*(\alpha)$ is the value of $\underline{t}$ corresponding to the peak point of the curve $g(\underline{t}, \alpha)$. Then, voting equilibrium on tax limitation will be the winning $\underline{t}$ in pair-wise voting among the possible alternatives, each $\underline{t}^*(\alpha)$ and the status quo.

Since the curve $g(\underline{t}, \alpha)$ plays an important role in finding voting equilibrium, let us consider the properties of the curve $g(\underline{t}, \alpha)$. First, given that $V(t(e^{**}, \alpha^*), e^{**}, \alpha)$ does not depend on $\underline{t}$, $g(\cdot)$ has properties similar to those of $V(\cdot)$, and $g(\cdot)$ is an inverted U-shaped curve in $\underline{t}$. Second, it follows directly from (20) that

$$g(0, \alpha) = V(0, \alpha) - V(t(e^{**}, \alpha^*), e^{**}, \alpha) < (>) 0 \qquad \text{for } \alpha \in S\,(F), \tag{22}$$

meaning that voters in $S\,(F)$ are worse (better) off under severe tax limitation, such as any $\underline{t}$ close to zero. Third, for any small limitation, such as any $\underline{t}$ close to the status quo, $t(e^{**}, \alpha^*)$, voters are definitely worse off than under the status quo itself, because the bureau decreases effort in response to the limitation, while there is little gain from reducing the bureau's tax bill. That is,

$$\lim_{\underline{t} \to t(e^{**}, \alpha^*)} g(\underline{t}, \alpha) = V(t(e^{**}, \alpha^*), \underline{e}, \alpha) - V(t(e^{**}, \alpha^*), e^{**}, \alpha) < 0$$

$$g(t(e^{**}, \alpha^*), \alpha) = 0 \qquad \text{for all } \alpha, \tag{23}$$

where the inequality comes from $\underline{e} < e^{**}$ and the last equality from the definition of $g(\underline{t}, \alpha)$ in (21). Thus, (23) implies that $g(\underline{t}, \alpha)$ is discontinuous at the status quo for all α.

Before we find the voting equilibrium on tax limitation, it proves useful to consider an example. Figure 2 shows a map of $g(\underline{t}, \alpha)$ curves, based on the above properties of $g(\underline{t}, \alpha)$, with $n = 3$ and $\alpha^* = 1$. All three $g(\cdot)$ curves are inverted U-shaped and discontinuous at the status quo, $t(e^{**}, \alpha^*) = t(e^{**}, 1)$. Using (22), the $g(\underline{t}, 1)$ curve starts from the origin while the $g(\underline{t}, 3)$ and $g(\underline{t}, 2)$ curves start from above and below the origin, respectively. Then, in pair-wise voting among the four alternatives $\{\underline{t}^*(3), \underline{t}^*(1), \underline{t}^*(2),$ and the status quo $= t(e^{**}, 1)\}$, $\underline{t}^*(1)$ defeats both $\underline{t}^*(3)$ and $\underline{t}^*(2)$, the status quo defeats $\underline{t}^*(1)$,[16] and both $\underline{t}^*(3)$ and $\underline{t}^*(2)$ defeat the status quo. Thus, the well-known cyclical majority problem arises, and hence in general no voting equilibrium under majority rule may exist.

[16]Note that $g(\underline{t}, 2) = g(\underline{t}, 3) = 0$ at the status quo, but that $g(\underline{t}, 2) < 0$ and $g(\underline{t}, 3) < 0$ at $\underline{t} = \underline{t}^*(1)$. Thus, a majority (voters 2 and 3) will support the status quo over $\underline{t}^*(1)$.

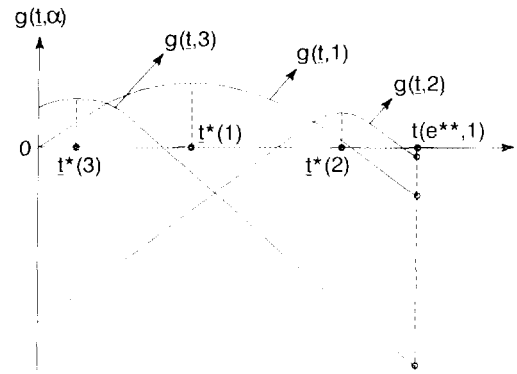

FIGURE 2

More generally, since discontinuity of $g(\underline{t}, \alpha)$ at the status quo means that $g(\underline{t}, \alpha)$ is not single peaked in $\underline{t}$, and since $g(0, \alpha) < 0$ for $\alpha \in S$ from (22),[17] voting equilibrium may not exist. We summarize this as follows:

PROPOSITION 3. *There may be no $\underline{t}$ on which voters agree under majority rule. (Voting equilibrium on tax limitation may not exist).*

To investigate in what circumstances voting equilibrium may exist, note that $g(\underline{t}, \alpha)$ is single peaked at all $\underline{t}$ except at the status quo, $t(e^{**}, \alpha^*)$. This means that if the agenda space is restricted to $\underline{t} \in [0, t(e^{**}, \alpha^*))$, voting equilibrium is the median decisive voter's most preferred $\underline{t}$, denoted $\underline{t}^*(m)$, where m is the median voter. Thus, if a majority is better off at $\underline{t}^*(m)$ than at the status quo, $\underline{t}^*(m)$ is still the voting equilibrium in the unrestricted agenda space, including the status quo, and we summarize this as follows:

LEMMA 1. *If $g(\underline{t}^*(m), \alpha) > 0$ for a majority, then there exists $\underline{t}$ on which voters agree under majority rule, and it is $\underline{t}^*(m)$.*

While the condition stated in the lemma can be satisfied under various assumptions, a simple assumption is that the utility function is separable between x and z, such that

$$V(t, e, \alpha) = U[I(\alpha) - t/n, t/c(e)] = f[I(\alpha) - t/n] + h[t/c(e)], \tag{24}$$

[17]Note that discontinuity of $g(\underline{t}, \alpha)$ at the status quo alone does not lead to the nonexistence of voting equilibrium. This is because if $g(0, \alpha) > 0$ for all α, then clearly everybody is better off at some $\underline{t}$ than under the status quo, and hence voting equilibrium exists and is some $\underline{t}$ which is the median voter's most preferred $\underline{t}$.

where $f[\cdot]$ and $h[\cdot]$ are monotonically increasing concave functions. Simple calculation shows that the separable utility function satisfies the following three properties: first, the public good is a normal good, meaning that the rich (poor) voters are higher (lower) demanders for the public good or tax bill. Given the assumption that $I(\alpha)$ increases in α, normality of the public good implies that $\underline{t}^*(\alpha)$ increases in α. Thus, since voters differ only in income, the median voter is voter k, and $\underline{t}^*(m) = \underline{t}^*(k)$.

Second, $t(e, \alpha)$ also increases in α, meaning that the maximum acceptable tax bill beyond which the net benefit from the public good becomes negative (or voters are worse off than under no public good) is higher for the rich voters. Since the bureau chooses the median of $t(e, \alpha)$ values, and since the median is $t(e^{**}, \alpha^*) = t(e^{**}, k)$ in this case,[18] as in (22),

$$g(0, \alpha) = V(0, \alpha) - V(t(e^{**}, k), e^{**}, \alpha) \geq (<)0 \qquad \text{for } \alpha \leq (>)k. \tag{25}$$

Third, by the definition of $g(\underline{t}, \alpha)$, for all $\underline{t} < t(e^{**}, k)$,

$$\begin{aligned} g(\underline{t}, \alpha) &= V(\underline{t}, \underline{e}, \alpha) - V(t(e^{**}, k), e^{**}, \alpha) \\ &= f[I(\alpha) - \underline{t}/n] + h[\underline{t}/c(\underline{e})] - f[I(\alpha) - t(e^{**}, k)/n] \\ &\quad - h[t(e^{**}, k)/c(e^{**})]. \end{aligned} \tag{26}$$

Then, $g(\underline{t}, \alpha)$ decreases in α since $g_\alpha(\underline{t}, \alpha) = I'(\alpha)f'[I(\alpha) - \underline{t}/n] - I'(\alpha)f'[I(\alpha) - t(e^{**}, k)/n] < 0$, which follows from the concavity of $f(\cdot)$ and from the fact that $\underline{t} < t(e^{**}, k)$.

Using the above three properties, Fig. 3 shows a map of $g(\underline{t}, \alpha)$ curves with $n = 3$. In the figure, note that since $k = 2$, the status quo is $t(e^{**}, k) = t(e^{**}, 2)$ and that $\underline{t}^*(3) > \underline{t}^*(2) > \underline{t}^*(1)$ by normality of the public good. Note also that $g(\underline{t}, \alpha)$ curves never intersect each other except at $\underline{t} = t(e^{**}, k) = t(e^{**}, 2)$ because of $g_\alpha(\underline{t}, \alpha) < 0$ for all $\underline{t} < t(e^{**}, k)$. Finally, from (25), the $g(\underline{t}, 2)$ curve starts from the origin while the $g(\underline{t}, 1)$ and $g(\underline{t}, 3)$ curves start from above and below the origin, respectively. In this case, pair-wise voting among the four alternatives clearly results in equilibrium, which is the median voter's most preferred outcome, $\underline{t}^*(k) = \underline{t}^*(2)$.

[18]Although in general α^* is a function of e^{**}, as noted above, in the case of the separable utility function the dependence disappears and $\alpha^* = k$.

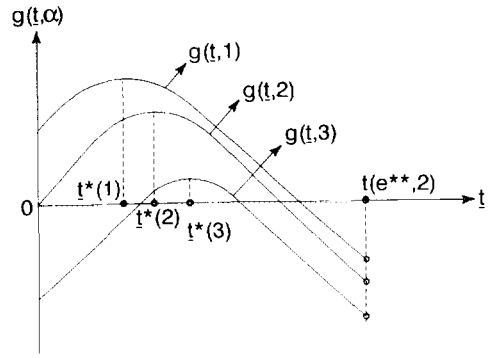

FIGURE 3

In general, the above properties of the separable utility function imply that $g(\underline{t}^*(m), m) = g(\underline{t}^*(k), k) > g(0, k) = 0$ from (25) and

$$g(\underline{t}^*(m), \alpha) = g(\underline{t}^*(k), \alpha) > g(\underline{t}^*(k), k) > 0 \quad \text{for } \alpha < k$$

from $g_\alpha(\underline{t}, \alpha) < 0$, satisfying the condition in Lemma 1 and leading to the following result:

PROPOSITION 4. *Assume that the cost of the public good is equally shared, and that* $U[x, z] = f(x) + h(z)$. *Then, there exists* $\underline{t}$ *on which voters agree under majority rule, and it is* $\underline{t}^*(k)$.

The proposition means that, under the assumption of the separable utility function, voters will impose a limitation that limits the tax bill to $\underline{t}^*(k)$ if the bureau proposes the tax bill $t(e^{**}, k)$. Therefore, the bureau may or may not prevent the tax limitation, depending on whether it is patient. Since this was already discussed in Proposition 2, we need not repeat it here and instead discuss a distributive consequence.

To see how the bureau's patience affects income distribution among voters, note that the bureau always chooses the larger tax bill (and the higher effort level) than voters if voters are indifferent between the two tax bills. Then, since the patient bureau chooses the tax bill to prevent tax limitation, while the impatient bureau allows voters to limit and choose the tax bill they desire, the tax bill would be larger when the bureau is patient than when it is impatient. Thus, given that the cost of the public good is equally shared, the patient bureau favors higher demanders of the public good, who are the rich voters. We state this result without proof as

follows:[19]

PROPOSITION 5. *Assume that the cost of the public good is equally shared, and that* $U[x, z] = f(x) + h(z)$. *Then, the impatient bureau would bring a more equitable outcome than the patient bureau.*

In interpreting the proposition, one should be cautious, because it was based on the specific utility function and the tax system. For instance, if the utility function is written as $U[x, z] = x + h(z)$ and the public good is financed by a proportional income tax, then the public good can be shown to be an inferior good. This means that the rich (poor) voters become lower (higher) demanders of the public good. Thus, the patient bureau favors higher demanders who are the poor voters and would bring a more equitable outcome than the impatient bureau, which is opposite to Proposition 5.

6. CONCLUSION

In closing, let us discuss the future research agenda and possible extensions of the analysis presented in this paper. First, tax limitation involves transactions cost, time and effort, on the part of voters, especially those who participate in forming the agenda. This consideration not only reduces the voters' welfare, but also raises a free-rider problem due to an attempt to save the transactions cost. Therefore, although the analysis did not consider this issue, one may expect that not all voters, but those who have a strong interest in tax limitation, will participate in forming the agenda. Since those voters are extremely high and low demanders of the public good, the agenda to place in the referendum would contain a small limitation or retain the status quo, favored by high demanders, or a severe limitation, favored by low demanders. This might explain why voters fail to impose limitations on the bureau's excessive tax bill, as well as why tax limitation is severe when imposed, like California's Proposition 13.

Second, it seems desirable to relate the issue to the regulation literature (for example, see Spulber [17]) and to the principal–agent literature, because the bureau is viewed as a monopoly agent that provides public goods for voters. The problem with the current form of tax limitation is that the bureau decreases effort in response to tax limitation, causing the cost of the public good to rise. To circumvent this problem, as the analysis suggested, the bureau should be given, along with a reduction in the tax bill, an appropriate incentive to produce the public good efficiently. Alternatively, voters may control the quantity or price of the public good,

[19]By "equitable" we mean "benefiting the poor." However, as a referee has pointed out that, precisely speaking, such a judgment must be made by weighing the relative changes of utility of the poor and the rich.

as discussed in Inman [6]. Further research on how to implement these alternatives seems warranted.

Third, voters may not have perfect information about the bureau's preferences and the cost of the public good. This means that voters do not know exactly what the world after tax limitation looks like. Thus, risk-averse voters may not change the status quo unless the expected value of the potential gain is significant. Furthermore, taking advantage of this, the bureau may threaten voters by exaggerating the adverse effect of tax limitation. This may offer another reason why voters fail to impose a limitation even though tax limitation makes them better off.

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