Taxes or Fees? The Political Economy of Providing Excludable Public Goods

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Abstract

This paper provides a positive analysis of public provision of excludable public goods financed by uniform taxes or fees. Individuals differing in preferences decide, using majority rule, the provision level and financing instrument. The decisive voter has median preferences in a tax regime, but generally has above median preferences in a fee regime. Numerical solutions indicate that populations with uniform or left-skewed distributions of preferences choose taxes, while a majority coalition of high- and low-preference individuals prefer fees when preferences are sufficiently right skewed. Public good provision and welfare under fees exceeds that under taxes in the latter case.

1. Introduction

Tiebout-like models of local public good provision with mobile consumers frequently encounter equilibrium existence problems. Incorporating voting into such models compounds the difficulty.[1] Modeling public provision of excludable public goods through user fees may suffer from similar problems because consumers exhibit mobility of a different nature. That is, consumers have the ability to opt out of consuming the good to avoid some, or all, of the

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[1]See Westhoff (1977), Epple et al. (1984), and Epple and Romer (1991).

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production cost. In multi-jurisdiction local public good models with voting, it is also assumed that consumers who leave a jurisdiction no longer vote in that jurisdiction. It is reasonable to assume, therefore, that individuals who opt out of paying a user fee (as well as consuming the public good) do not concern themselves with further increases in the fee as they are unaffected by such changes. That is, non-subscribers become apathetic to changes in a fee. This view seems consistent with fee-based provision examples in the field, and it opens the interesting possibility that in a political economy model of user fee and public good determination, the set of voters is endogenous and determined by the set of subscribers. While, to our knowledge, this idea has not been pursued in the specific context of an excludable public good, our approach is an application of the theory of group formation as presented in Caplin and Nalebuff (1997), in which the economic environment determines the building of coalitions or institutions and, *vice versa*, institutions affect equilibrium outcomes. We analyze the characteristics of equilibrium and show that a model of user fee determination is useful in explaining why fees may be preferred to taxes for the public provision of excludable public goods.

Many excludable public goods are provided by the state. Examples in the United States include national, state, and local parks, state and federal wildlife programs that stock and monitor fish and game for sportsmen, and outdoor recreation areas for hiking, backpacking, bicycling, or cross-country skiing. In Europe, reception of public television broadcasts requires households to purchase a license. Issues related to both the level of provision and financing method are increasingly subject to public debate because the possibility of exclusion permits both tax-based provision and fee-based provision by the state.[2] Under the tax-based provision regime examined here, all individuals pay the average cost of provision through taxes. Once the good is provided, all individuals may consume the good at no additional charge. Under fee-based provision of public goods, individuals may opt out and pay no fee, but are then excluded from consuming the good.

From a normative standpoint exclusion of individuals under a fee-based system indicates an inefficiency if the marginal cost of additional consumers is zero. Whether taxes are superior or not, however, depends also on the level of the provision under each regime and the progressivity of the financing. Fraser (1996), therefore, considers the welfare ranking of tax versus fee-based public provision regimes for an excludable public good. He shows that when government sets the fee or tax to maximize utilitarian social welfare, the good is underprovided under fees relative to tax-based provision. Often, however, we observe that fee-based financing schemes find strong public support, even from those who are most likely the consumers. Consider the recent statement

[2]For example, compare the positive response of Fretwell (1999) and Crandall (in U.S. Senate 1999) to increased use of fees by the U.S. National Park Service to the negative response of a number of other organizations. A list of organizations opposed to the fees can be found at http://www.freeourforests.org/opposition.html.

by Derrick Crandall, President of the American Recreation Coalition (ARC), to the U.S. Senate Committee on Energy and Natural Resources:

> We perceive fees as one element in assuring the public that their visits to their lands will be enjoyable and safe. The recreation community enjoys free lunches just as much as any other interest group, but we have come to understand that it is hard to demand a great meal when you aren't paying. And we certainly understand that quality recreation on federal lands really isn't a free lunch: the costs have simply been borne by general taxes, not user fees. However, there is a real downside to that situation. We've seen that during recent periods of financial pressure on the federal government, recreation programs are placed in jeopardy . . . Americans across the country made clear that they were willing to pay reasonable fees for quality recreation opportunities—just as they will pay reasonable costs for quality sleeping bags and boats. (U.S. Senate 1999, p. 9)

The support for fees seems difficult to reconcile with the normative perspective. In this paper we consider a political economy approach to explain this stylized fact. In contrast to Fraser, we show that when the financing instrument and level of provision are chosen through majority-rule voting, fees can provide a higher level of the public good relative to taxes in some cases. Furthermore, fees may be preferred by a majority of individuals in these cases.

The main logic behind these findings is straightforward. Individuals with strong preferences for the good prefer and vote for higher fees or taxes than individuals with low preferences. If tax financing is chosen, strong-preference individuals face resistance from *all* low-preference individuals to a tax increase because everyone has to pay a tax. Thus, the equilibrium tax can be no higher than that most preferred by the individual with the median preferences. However, because low-preference individuals have the ability to opt out under fees, they become indifferent over marginal changes in a fee if the current level already exceeds their maximum willingness to pay. Therefore, some low-preference individuals abstain from voting over increases. This makes the voting population endogenous, as explained earlier. Hence, strong-preference individuals face less opposition to fee increases than tax increases. This explains how the equilibrium fee can be higher than the median type's ideal fee. Depending on the distribution of preferences, fees may actually lead to greater public good provision, inducing some high-preference individuals to prefer fees to taxes. In addition, low-preference individuals may vote together with high-preference individuals in favor of fee financing because it allows them to avoid tax payments that are too high from their standpoint.

The latter result depends on the overall distribution of preferences. We use numerical techniques to gain further insight. When preferences are distributed uniformly or are left skewed, implying a population where most individuals have relatively strong preferences for the good, a majority of individuals prefers tax-based provision. When preferences are right skewed, the majority may prefer fee-based provision. The level of public good provision under fee financing is lower relative to tax financing when the distribution of preferences is uniform or left skewed, but may exceed that under tax financing when the distribution of preferences is right skewed. While our main focus is to analyze the provision from a positive viewpoint, we also rank political and welfare maximization outcomes in terms of utilitarian welfare.

Our analysis builds on several previous works. A vast literature on club theory, as introduced by Buchanan (1965), focuses on the potential for excludable public goods to be efficiently provided by a private, decentralized, competitive network of clubs. Brito and Oakland (1980) examine the question of private market provision of an excludable public good under conditions of a monopoly and find that a monopoly leads to underprovision relative to the socially optimal level. Our analysis differs from the club literature by considering goods for which natural, locational, or jurisdictional barriers prevent free entry by potential providers.[3]

Bös (1980) compares fees and taxes in a political economy framework. In contrast to our approach, however, he considers the provision of a private good, of which consumers consume different but positive amounts. The tax is a progressive linear income tax and is only partially endogenized. The main focus of Bös is, therefore, on redistributional issues and not on the excludability property.

Our work has a clear link to the literature on public versus private provision of education. Most of these papers consider the ability of households to opt out of public education for a private alternative when the level of public education is unsatisfactory. The "ends against the middle" voting outcome in Epple and Romano (1996) bears strong resemblance to voting outcomes derived here, but for significantly different reasons. In Epple and Romano, a coalition of high- and low-income households opposes middle-income households who prefer higher expenditures for public education. Low-income households oppose higher expenditures because of the high opportunity cost of increased expenditures, while high-income households oppose them because they prefer to opt out of public education for a higher quality private alternative. In the current analysis, low-preference individuals prefer fees to taxes because they can opt out under fees, while high-preference individuals may prefer fees to taxes when fees provide a higher quality of the public good than taxes. This can generate a similar "ends against the middle" voting outcome.

Helsley and Strange (1998) examine the strategic interaction between a private government and the public sector. Private governments are

[3]For example, Yellowstone National Park has unique factors of production that are not readily available to potential competitors. Although our analysis considers a single provider, it differs from that of Brito and Oakland because it is primarily concerned with those goods that are publicly rather than privately provided, and, therefore, can potentially be funded through a balanced government budget financed by taxes or fees.

organizations that are voluntary, exclusive, and supplement services provided by the public sector. Private governments form when a group of consumers is dissatisfied with the level of a public service being provided by the public sector. In the Helsley and Strange analysis, consumers determine the level of public good provision by supplementing public provision levels, while consumers in the current analysis determine the level of public good provision by choosing the form and level of public funding. Oakland (1972), Laux-Mieselbach (1988), and Silva and Kahn (1993) all address the degree and optimality of exclusion. Here, it is assumed that exclusion is perfect and costless to the providing agency.

The paper is structured as follows. Section 2 presents the general model and characterizes the level of the tax and fee, respectively, under majority voting. In Section 3 we use numerical analysis to examine how changes in key parameters affect the voting equilibrium. In Section 4, we characterize the policy equilibrium, that is, the choice between fee and tax as instrument. Section 5 concludes and discusses future research.

2. The Model

A population of size one is a continuum of individuals who derive utility from a non-rival, excludable, collective good, G, and a pure, composite, private, *numeraire* good, m. Each individual is endowed with m_0 units of the *numeraire*. Individuals have heterogeneous preferences for the public good. The utility of a type θ individual who consumes m units of the private good and G units of the collective good is

$$U(m, G; \theta) = m + \theta v(G). \tag{1}$$

The function $v(G)$ is assumed to be smooth, strictly increasing, and strictly concave and is the same for all individuals. We also assume $v(0) = 0$. Individual type θ is distributed with continuous, atomless distribution function $F(\theta)$ and density function $f(\theta)$ on the interval $\theta \in [\underline{\theta}, \bar{\theta}]$ with $\underline{\theta} \geq 0$ and $\underline{\theta} < \bar{\theta} < \infty$.

We consider two types of regimes for financing good G.[4] In a tax regime each individual pays a tax t and private consumption is $m_0 - t$. In a fee regime an individual who subscribes pays a fee s and spends the remainder on the private good. The budget constraint faced by each individual takes the form

$$m = m_0 - \begin{cases} t & \text{if tax} \\ \delta s & \text{if fee,} \end{cases} \tag{2}$$

[4]To make our point as simple as possible, we consider only two easily implemented financing schemes. We abstract from more complicated revelation mechanisms that could be beneficial when information about preferences is incomplete.

where δ is an indicator variable which takes the value of 1 if the individual subscribes and 0 otherwise.

The public agency providing G is assumed to be non-profit and to have a balanced budget. The marginal cost of additional units of G is assumed to be constant, equal to 1, and known by everyone. Thus, recalling that the population is normalized to 1, the government budget constraint is of the form

$$G = \begin{cases} t & \text{if tax} \\ sn & \text{if fee,} \end{cases} \tag{3}$$

where n represents the fraction of the population that subscribes.

Through the political process society decides, using majority rule, whether a tax or fee regime is implemented and determines the level of the fee or tax. We can model this as a three-stage process. At Stage 1, individuals choose the method of financing provision of the public good, either through taxes or fees. At Stage 2, individuals choose the level of the tax or fee that is imposed. If fees were chosen at Stage 1, each individual also decides at Stage 3 whether or not to pay the fee and consume the public good, or spend his entire endowment on the private good. No decision has to be made under the tax regime in Stage 3. The three-stage public choice process is solved using backward induction. We assume that all individuals vote sincerely, that is, at Stages 1 and 2 each individual votes for the policy that gives highest utility, taking into account how current decisions affect behavior in later stages. In the remainder of this section, we solve for Stages 2 and 3 under both regimes.

2.1. Tax-Based Provision

Under tax-based provision, the public good is financed via a mandatory, non-negative, lump-sum head tax $t \in [0, m_0]$ paid by all individuals in the population. The pool of consumers under a tax is the entire population. Furthermore, because utility from the public good is non-negative and consumption requires no additional cost to the individual, all individuals find it optimal to consume the good. Combining conditions (1)–(3), the utility of a type θ individual paying a tax of t is, therefore,

$$U(m_0 - t, t; \theta) = m_0 - t + \theta v(t). \tag{4}$$

An individual's most preferred tax rate depends on θ. Maximizing (4) with respect to the tax rate gives the most preferred tax rate

$$t(\theta) = \begin{cases} 0 & \text{if } v'(0) < 1/\theta \\ v'^{-1}(1/\theta) & \text{if } v'(0) \geq 1/\theta \geq v'(m_0) \\ m_0 & \text{if } v'(m_0) > 1/\theta. \end{cases} \tag{5}$$

Assuming for a moment that $t(\theta)$ is strictly between 0 and m_0, we find by differentiating the middle branch of (5) that most preferred tax rates are an increasing function of θ,

$$\frac{\partial t(\theta)}{\partial \theta} = \frac{-v'(t(\theta))}{\theta v''(t(\theta))} > 0. \tag{6}$$

The equilibrium tax t^e under majority-rule voting is the tax that defeats any alternative tax in a pairwise vote. Note that preferences over tax rates are single-peaked on the interval $[0, m_0]$ because (4) is strictly concave in t. Hence the median voter result can be invoked.[5] This leads to the following standard result. *In a tax regime, the equilibrium tax under majority-rule voting is the tax most preferred by the individual with the median preferences* θ^m, that is, $t^e = t(\theta^m)$.

2.2. Fee-Based Provision

All individuals desiring access to the public good must pay a one-time subscription fee, s. Hereafter, we refer to individuals choosing to pay the fee and consume the good as subscribers. Non-subscribers are individuals who choose to opt out. We assume that access to the public good is characterized by imperfect or coarse exclusion (Helsley and Strange 1991), which implies that subscribers cannot be charged differently based on their intensity of use or number of uses. The utility of a type θ individual under fee-based provision, therefore, is

$$U(m, G; \theta) = m_0 + \max\{0, \theta v(G) - s\}. \tag{7}$$

Our analysis proceeds in several steps. We first describe the *subscription equilibrium* in the third stage given some fee s. We then analyze the *voting equilibrium* that is characterized by the most preferred policy of the median of those who subscribe.

The first step is to find the number of subscribers for arbitrary levels of the fee and public good. This requires identifying the marginal consumer who is just indifferent between subscribing and not subscribing, that is, finding the individual for whom $\theta v(G) - s = 0$. Because utility in (7) is non-decreasing in θ and strictly increasing in θ when $\theta v(G) > s$, there exists a $\hat{\theta}$ such that $\hat{\theta} = s/v(G)$. Naturally, individuals with high preferences subscribe, while low-preference individuals do not. For $G > 0$, the individual with type $\hat{\theta}$ is the marginal consumer, where

$$\hat{\theta}(s, G) = \begin{cases} \underline{\theta} & \text{if } \ \underline{\theta} > s/v(G) \\ s/v(G) & \text{if } \ \underline{\theta} \leq s/v(G) \leq \bar{\theta} \\ \bar{\theta} & \text{if } \ \bar{\theta} < s/v(G), \end{cases} \tag{8}$$

and $\hat{\theta}(s, 0) = \bar{\theta}$. All individuals with type $\theta \geq \hat{\theta}$ choose to subscribe to the public good, while all individuals with type $\theta < \hat{\theta}$ do not subscribe.

[5] See Downs (1957) or Black (1958).

The supply of the public good depends on the fee s and the number of subscribers. For any levels of s and $\hat{\theta}$, the supply of the public good is

$$G(s, \hat{\theta}) = s[1 - F(\hat{\theta})], \tag{9}$$

where $n = [1 - F(\hat{\theta})]$ is the proportion of individuals with $\theta \geq \hat{\theta}$ (i.e., those who choose to subscribe). Given any fee s, we define a *subscription equilibrium* as a pair $(G(s), \hat{\theta}(s))$ such that:

(1) The marginal subscriber is given by (8);
(2) The government budget (9) is balanced;
(3) All individuals with type $\theta > \hat{\theta}(s)$ prefer subscribing to not subscribing, and all individuals with type $\theta < \hat{\theta}$ prefer not subscribing to subscribing; and
(4) No subset of non-subscribers can increase their utility by jointly subscribing.

Conditions 1–3 were discussed above. The fourth part in the equilibrium definition establishes that the equilibrium is *coalition-proof* (Bernheim et al. 1987). That is, if multiple solutions to (8) and (9) exist for a given fee s, condition (4) selects the fee that involves the greatest number of subscribers, and, therefore, the greatest level of public good provision. This assumption also is attractive in that, because the good is perfectly non-rival, an equilibrium with more subscribers Pareto-dominates an equilibrium with fewer subscribers.

We now establish that the function $\hat{\theta}(s)$—and, therefore, also the function $G(s)$—exists. Note that the function $\hat{\theta}(s)$ is implicitly defined via (8) and (9) by $H(s, \hat{\theta}) := \hat{\theta} v(G(s, \hat{\theta})) - s = 0$. We can apply the implicit function theorem to show existence because the partial derivatives of $H(s, \hat{\theta})$ with respect to s and $\hat{\theta}$ exist and are continuous, and at a solution to $H(\cdot) = 0$, the partial derivative of H regarding $\hat{\theta}$ is nonzero in general.

We are now in position to define a voting equilibrium. A fee s is a *voting equilibrium* if

(1) $(G(s), \hat{\theta}(s))$ is a subscription equilibrium;
(2) the fee s is a Condorcet winner; that is, under majority voting s wins against any other fee s', where the set of voters is $[\min\{\hat{\theta}(s), \hat{\theta}(s')\}, \bar{\theta}]$ and $(G(s'), \hat{\theta}(s'))$ is a subscription equilibrium.

Implicit in the second part of the definition is an assumption on voting behavior when individuals vote over two different fees and some individuals would opt out under both. We assume that these individuals abstain from voting, perhaps because of small but positive voting costs, or vote for either fee with probability one half. Other voting behavior could lead to different outcomes, but our assumption has intuitive appeal. It should also be noted here that voters are sophisticated because they take into account how changes in s affect the number of subscribers.

The first step in deriving the voting equilibrium is the characterization of individual preferences over fees. In particular, we wish to prove that types and preferred fees are positively correlated.

LEMMA 1: *Individuals with higher types have (weakly) higher most preferred fees.*

Proof: An individual with type θ has an optimal fee s. Denote the relationship $s(\theta)$. We want to prove that $s(\theta_2) \geq s(\theta_1)$ if $\theta_2 > \theta_1$. For convenience we call $s_2 = s(\theta_2)$ and $s_1 = s(\theta_1)$. Assume for the moment that each type strictly prefers her ideal fee over the other fee, that is,

$$\theta_1 v(G(s_1)) - s_1 > \theta_1 v(G(s_2)) - s_2$$

and

$$\theta_2 v(G(s_2)) - s_2 > \theta_2 v(G(s_1)) - s_1,$$

which implies

$$\theta_1[v(G(s_2)) - v(G(s_1))] < s_2 - s_1 < \theta_2[v(G(s_2)) - v(G(s_1))]. \quad (10)$$

Condition (10) implies that $G(s_2) > G(s_1)$ because $\theta_2 > \theta_1$ by assumption. But this makes the left-hand side of (10) positive and, therefore, $s_2 > s_1$.

We assumed above that each individual had a strict preference for her ideal fee. Suppose that one individual was indifferent between s_1 and s_2. Then the other individual must have a strict preference, because both individuals cannot be indifferent and have different types. In this case (10) will have one strict inequality and the proof above holds. The ordering of ideal fees and types is weak because the maximum feasible fee is m_0 and, therefore, individuals with very high types may have the same most preferred fee. ■

Monotonicity of most preferred fees is not sufficient to establish a voting equilibrium. Unfortunately, application of well-established conditions to prove existence of a Condorcet winner—like the single-crossing property (see Gans and Smart 1996 or Persson and Tabellini 2000)—is not possible here due to the opting-out option. Single-crossing requires that when a high type prefers policy p_1 over p_2, where $p_2 > p_1$, an individual with a lower type will have a weak preference for p_1 as well. This property is used to prove existence of a Condorcet winner, where the winning proposal is equal to the ideal policy of the median preference person, because all individuals with types below the median prefer the median's ideal policy to any higher policy, and all types above the median prefer the median proposal to any lower policy. This logic does not apply here. When low types opt out under the median's ideal fee and some other alternative fee, the ranking of these two fees by a higher type is not clear, including the possibility that a high-type individual prefers the higher of the two fees. Put differently, when some people opt out at the ideal fee of the median type, this fee cannot be a Condorcet winner.

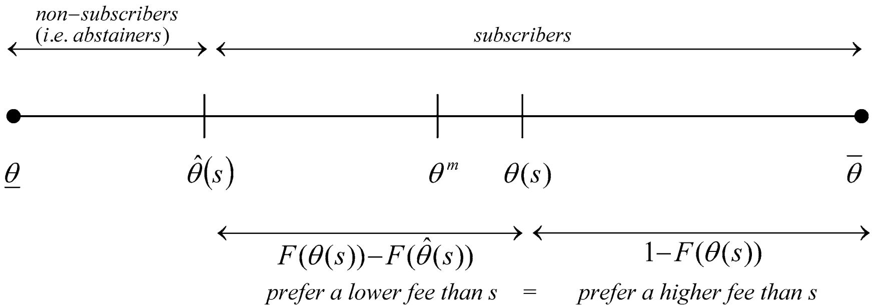

Figure 1: The necessary condition for an equilibrium fee

This forces us to make a different assumption. We can prove single-peakedness of preferences, a condition stronger than single-crossing, if the government budget function $G(s)$ is not too convex. If an interior solution $s \in (0, m_0)$ for an individual's maximization problem exists, it is characterized by

$$-1 + \theta v'(G(s))G'(s) = 0. \tag{11}$$

The second order condition $\theta[v'(G(s))''(s) + v''(G(s))(G'(s))^2] < 0$ is satisfied if $G''(s) < -v''(G(s))(G'(s))^2/v'(G(s))$, that is, $G(s)$ is not too convex. The interior solution applies if $v'(0)G'(0) > 1/\theta$ and $v'(m_0)G'(m_0) < 1/\theta$. When $v'(0)G'(0) < 1/\theta$, the optimal fee is 0, and if $v'(m_0)G'(m_0) > 1/\theta$, the optimal fee is m_0. These properties imply that preferences are single-peaked.

It is hard to characterize in terms of fundamentals of the model when $G(s)$ is not too convex. However, it is not an empty assumption, as we will verify numerically later.[6] When preferences are single-peaked, we can now derive a necessary condition that an equilibrium fee s must satisfy. The number of people who prefer a fee higher than s, $1 - F(\theta(s))$, must be equal to the number of people who prefer a smaller fee and choose to pay $s, F(\theta(s)) - F(\hat{\theta}(s))$. In other words, the equilibrium fee is the one chosen by the median of non-abstainers. This condition can be written as follows:

$$1 - F(\theta(s)) = F(\theta(s)) - F(\hat{\theta}(s)), \tag{12}$$

where $\theta(s)$ is the individual who most prefers s, and $\hat{\theta}(s)$ is the marginal consumer type at s. Figure 1 presents the necessary condition for an equilibrium fee graphically. In the figure, θ^m represents the overall median preference individual, but $\theta(s)$ represents the median of the subscribers at the fee s and satisfies (12). The next result establishes this and further insights formally.

[6] In this sense our approach is similar to Epple and Romano (1996).

PROPOSITION 1: *Let $s(\underline{\theta})$ and $s(\bar{\theta})$ be the most preferred fees of the lowest and highest types, respectively. Assume that $s(\underline{\theta}) < s(\bar{\theta})$ and more than half of the population prefers a fee strictly between* 0 *and* m_0.

(a) *A necessary condition for s to be a voting equilibrium is that it solves (12).*

(b) *There exists at least one fee for which (12) holds.*

(c) *If a voting equilibrium fee exists, the equilibrium fee is the smallest of all fees that fulfill (12).*

Proof: (a) Suppose condition (12) does not hold. Then there exists a fee in the neighborhood of s which would win in a pairwise vote against s because preferences are single-peaked. If $1 - F(\theta(s)) < F(\theta(s)) - F(\hat{\theta}(s))$, then a slightly smaller fee than s wins. A slightly higher fee wins in a pairwise vote if the inequality is reversed.

(b) Begin by considering the most preferred fee of the lowest type individual $s(\underline{\theta})$. By Lemma 1 no individuals prefer a lower fee than $s(\underline{\theta})$, while by assumption a majority of individuals prefer a strictly higher fee. Therefore, $s(\underline{\theta})$ would lose to a slightly higher fee in a pairwise vote. The same logic allows us to rule out $s(\bar{\theta})$. We can apply the intermediate value theorem because $F(\theta)$ is continuous, to show that there must exist at least one fee for which the proportion of individuals preferring a slightly higher fee exactly equals the proportion of individuals preferring a slightly lower fee.

To see that a solution is indeed an equilibrium, as defined above, we must also prove that it is consistent with the opting out behavior. Existence is straightforward if at the most preferred fee of the median type all individuals subscribe. The set of voters comprises everyone and the decisive voter is the median type. By assumption at this person's optimal fee all subscribe.

When some individuals opt out at the median person's ideal fee, we construct a fixed-point argument by looking at the mapping of $[\underline{\theta}, \bar{\theta}]$ onto itself. Recall that θ^m denotes the median θ person overall, and $\hat{\theta}$ denotes the marginal subscriber. Let $\hat{\theta}^m$ and $s(\hat{\theta}^m)$ denote the median of subscribers and the median's ideal fee, where $\hat{\theta}^m$ is a function of $\hat{\theta}$, given the distribution of preferences. Start with $\hat{\theta} = \underline{\theta}$. By assumption the entire population subscribes. The lowest θ person is indifferent between subscribing and not subscribing and hence, $\hat{\theta}^m = \theta^m$, (i.e., the median agent in the set of subscribers is the median θ person overall). If at the ideal fee of this person, not all subscribe, we have $\phi(s(\hat{\theta}^m(\underline{\theta}))) > \underline{\theta}$, where $\phi(s)$ is the function that indicates for each fee s the identity of the marginal consumer. By contrast when $\hat{\theta} = \bar{\theta}$, $\hat{\theta}^m = \bar{\theta}$ holds by assumption (the only subscribers are the highest θ people who then are also representing the median of subscribers). The fee most preferred by them is $s(\bar{\theta})$ and the corresponding marginal consumer is $\phi(s(\hat{\theta}^m(\bar{\theta}))) \leq \bar{\theta}$. By continuity of the functions $\hat{\theta}^m(\hat{\theta})$, $s(\hat{\theta}^m)$ and $\phi(s)$ there must exist now a $\hat{\theta}$ from $[\underline{\theta}, \bar{\theta}]$ such that $\phi(s(\hat{\theta}^m(\hat{\theta}))) = \hat{\theta}$.

(c) Suppose that s_1 and s_2 satisfy Equation (12) and $s_1 < s_2$. From Lemma 1 we know that the individual types who prefer s_1 and s_2 satisfy $\theta(s_1) < \theta(s_2)$ and thus $F(\theta(s_1)) < F(\theta(s_2))$. This, together with (12) implies $F(\theta(s_2)) - F(\hat{\theta}(s_2)) = 1 - F(\theta(s_2)) < 1 - F(\theta(s_1)) = F(\theta(s_1)) - F(\hat{\theta}(s_1))$.

Notice that this requires $F(\hat{\theta}(s_1)) < F(\hat{\theta}(s_2))$, and hence implies also that $\hat{\theta}(s_1) < \hat{\theta}(s_2)$. We can now demonstrate that s_1 wins against s_2. Suppose that $\hat{\theta}(s_2) \leq \theta(s_1)$. All individuals with type between $\hat{\theta}(s_1)$ and $\theta(s_1)$ vote for s_1. In addition, some individuals of a type slightly higher than $\theta(s_1)$ vote for s_1 as well. Let $\tilde{\theta}$ denote the individual who is just indifferent between s_1 and s_2. It must be the case that $\theta(s_1) < \tilde{\theta} < \theta(s_2)$, and hence $F(\tilde{\theta}) > F(\theta(s_1))$. The fee s_1 wins a majority if $F(\tilde{\theta}) - F(\hat{\theta}(s_1)) > 1 - F(\tilde{\theta})$. This is the case because $F(\tilde{\theta}) - F(\hat{\theta}(s_1)) > F(\theta(s_1)) - F(\hat{\theta}(s_1)) = 1 - F(\theta(s_1)) > 1 - F(\tilde{\theta})$.

Alternatively, suppose that $\hat{\theta}(s_2) > \theta(s_1)$. For s_1 to win a majority it is sufficient to show that $F(\hat{\theta}(s_2)) - F(\hat{\theta}(s_1)) > 1 - F(\hat{\theta}(s_2))$. This holds because $F(\hat{\theta}(s_2)) - F(\hat{\theta}(s_1)) > F(\theta(s_1)) - F(\hat{\theta}(s_1)) = 1 - F(\theta(s_1)) > 1 - F(\hat{\theta}(s_2))$. ■

The intuition for part (c) is that an overall equilibrium fee must first be a local candidate that satisfies (12), otherwise it would lose to a slightly larger or smaller fee in a pairwise vote. Moreover, only the smallest of the local candidate fees can be an overall equilibrium because a smaller local candidate will defeat a larger local candidate in a pairwise vote. This is because the smaller local candidate fee gets the vote from all subscribers below the individual who most prefers the smaller fee, and the smaller fee picks up some additional votes from a subset of individuals with only slightly higher θ types.

Condition (12) is useful in characterizing the equilibrium. In fact, we can now state one insight that is readily apparent from Figure 1. If all individuals subscribe at the most preferred fee by the individual with median preference (called $s(\theta^m)$), then the equilibrium fee is the one preferred by the median person. No alternative lower fee can be introduced which defeats $s(\theta^m)$ because there are no additional individuals to subscribe. In that case, $s(\theta^m)$ satisfies all of the equilibrium conditions, and we have $s^e = s(\theta^m)$. However, if a positive number of individuals opt out at $s(\theta^m)$, then that fee *cannot* be an equilibrium fee under majority-rule voting because it violates (12).

Proposition 1 provides a necessary condition for an equilibrium fee to exist. However, the result does not rule out the possibility that a much smaller fee, which does not satisfy (12), would beat in a pairwise comparison the smallest of all fees that satisfy (12). Hence, a majority voting equilibrium may fail to exist. A sufficient condition for the candidate fee s to beat any smaller fee s' is

$$1 - F(\tilde{\theta}) > F(\tilde{\theta}) - \min\{F(\hat{\theta}(s')), F(\hat{\theta}(s))\}, \tag{13}$$

where $\tilde{\theta}$ is the individual who is indifferent between s and s'. It is easy to show that the sufficient condition is satisfied if $\hat{\theta}(s') > \hat{\theta}(s)$. However, this case is not likely to hold as we show later in numerical simulations. When $\hat{\theta}(s') < \hat{\theta}(s)$, it is difficult to prove that (13) holds for all possible distributions $F(\theta)$. We, therefore, proceed under the assumption that the sufficient condition is indeed satisfied. Generally speaking, this is the case if the function $\hat{\theta}(s)$ is relatively flat because then the alternative fee s' picks up few voters at the lower end and hence loses against s, as our numerical simulations indicate.

We now turn to the main question of the analysis. Which of the two financing methods is chosen under majority voting? In order to gain additional insight into the problem under consideration, we first present the results of numerical simulations. We then comment on the numerical results together with the discussion of the *policy equilibrium* in Section 4.

3. Numerical Results

In this section, we solve a numerical example to show that a *voting equilibrium* under fee-based provision exists for specific functional and parametric assumptions.[7] That is, the functions and parameters discussed below generate the following outcomes:

(1) A *subscription equilibrium* exists for every fee $s \in [0, m_0]$,[8]

(2) $G(s)$ is strictly concave on $[0, s(\bar{\theta})]$,[9]

(3) Preferences are single-peaked on $[0, m_0]$, and

(4) The smallest fee that satisfies (12) defeats any smaller fee in a pairwise vote.

Therefore, a *voting equilibrium* exists, as characterized in Section 2.

The numerical approach allows us also to examine how variations in the distribution of individual preferences affect the equilibrium policy choice, as analyzed in Section 4. Solving the model numerically requires specifying

[7]All numerical solutions were solved using MAPLE. A MAPLE transcript of all calculations and solutions is available from the authors upon request.

[8]The level of the endowment has no effect on the equilibrium outcomes, provided that it is non-binding. We assume this to be the case throughout.

[9]Note that $G(s)$ is linear over any range of fees for which the subscription set is unchanging. This could make $G(s)$ non-concave over some range of s and strictly concave over another range of s. However, because $\underline{\theta} = 0$ in each of the simulations and the distributions are continuous, the subscription set continuously changes, and $G(s)$ is non-linear in general.

functional forms for $v(G)$ and $F(\theta)$, and assuming specific parameter values. The function that is used for $v(G)$ throughout is

$$v(G) = \frac{G}{1+AG}, \tag{14}$$

where $A \geq 0$. For $A = 0$, we have $v(G) = G$. For $A > 0$, $v(G)$ is strictly concave, with the degree of concavity increasing as A rises. To allow for skewed preferences while at the same time maintaining a fairly simple distribution function, we use a "stepwise uniform" distribution function for preferences where

$$\begin{aligned} F(\theta) &= \frac{\theta(2+\gamma)}{2\bar{\theta}} & \forall\, 0 \leq \theta \leq \frac{\bar{\theta}}{(2+\gamma)} \\ F(\theta) &= \frac{1}{2} + \frac{\theta(2+\gamma) - \bar{\theta}}{2\bar{\theta}(1+\gamma)} & \forall\, \frac{\bar{\theta}}{(2+\gamma)} < \theta \leq \bar{\theta}, \end{aligned} \tag{15}$$

with $-1 \leq \gamma < \infty$. This distribution function was formed by taking a uniform distribution between $\underline{\theta}$ and $\bar{\theta}$, setting $\underline{\theta}$ to zero, and defining the median preferences to be $\frac{\bar{\theta}}{(2+\gamma)}$. The functional forms (14) and (15) allow us to characterize the outcomes as a function of the distribution of preferences only, as given by the parameter γ. Furthermore, these functions lead to a quadratic solution to $\hat{\theta}(s)$, making the analysis nicely tractable.[10] Changes in the parameters A and $\bar{\theta}$ have no deeper meaning and do not qualitatively affect any of the results.

While facilitating the numerical calculations, the use of this distribution function also has intuitive appeal. For $\gamma = 0$ we have a simple uniform distribution of types between 0 and $\bar{\theta}$ with median preferences $\frac{\bar{\theta}}{2}$. For $\gamma > 0$, preferences become right skewed (i.e., the distribution of preferences becomes more dense on the low end). The individual with the median preferences has a type that approaches zero as γ approaches infinity. Graphically, the distribution of preferences with positive γ has the right-skewed shape of Figure 2. However, left-skewed preferences can be analyzed by setting γ between 0 and -1. The median consumer has a type that approaches $\bar{\theta}$ as γ approaches negative one. The distribution of preferences becomes more dense on the high end when γ is negative.

Let t^e and $G(t^e)$ be the tax and corresponding public good level predicted in Stage 2 under tax-based provision. Let s^e and $G(s^e)$ be the fee and corresponding public good level predicted in Stage 2 under fee-based provision. Table 1 presents the equilibrium values of θ^m, t^e, $G(t^e)$, s^e, and $G(s^e)$ for $A = 0.25$, $\bar{\theta} = 100$, and letting γ vary from -0.6 (indicating left-skewed preferences) to 18 (indicating significantly right-skewed preferences). For

[10]Recall that when multiple $\hat{\theta}(s)$ solutions exist, only the smallest value for $\hat{\theta}(s)$ satisfies our definition of *subscription equilibrium*. Thus, we use the lowest $\hat{\theta}(s)$ values throughout the simulations.

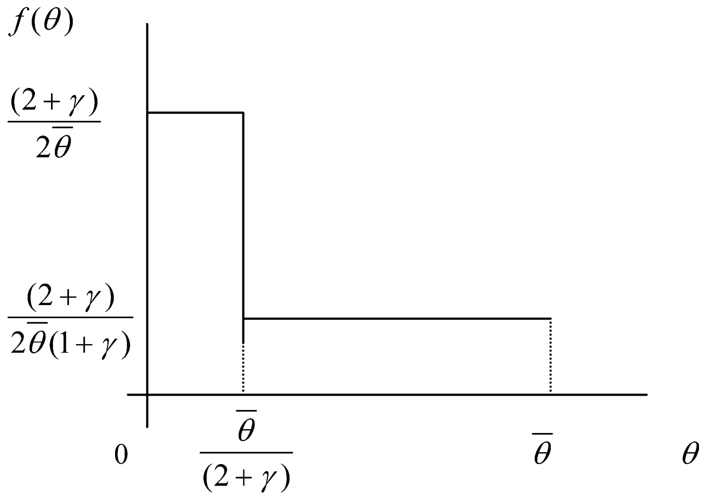

Figure 2: A right-skewed distribution of preferences

$\gamma = 0$, preferences are uniformly distributed and, therefore, unskewed. We now turn to the question of which instrument, taxes or fees, is chosen by majority vote.

4. Tax versus Fee: The Equilibrium Policy Choice

In this section, we characterize the *policy equilibrium*. A financing instrument (tax or fee) is an equilibrium policy choice if it receives majority support, assuming that all voters predict correctly the levels of each instrument and the corresponding public good levels that would result in Stages 2 and 3 (sophisticated voting). An individual of type θ strictly prefers fees over taxes if

$$\max\{0, \theta v(G(s^e) - s^e)\} > \theta v(G(t^e)) - t^e, \tag{16}$$

Table 1: Voting equilibrium values for θ^m, t^e, $G(t^e)$, s^e, and $G(s^e)$ under alternative parameterizations of the model

Simulation	Left Skewed	Uniform	Right Skewed	Right Skewed	Right Skewed
Parameter Values	$\gamma = -0.6$	$\gamma = 0$	$\gamma = 2$	$\gamma = 8$	$\gamma = 18$
θ^m	71.4286	50	25	10	5
t^e	29.8062	24.2843	16	8.6491	4.9443
$G(t^e)$	29.8062	24.2843	16	8.6491	4.9443
s^e	30.0204	25.0670	18.8072	17.4768	10.9432
$G(s^e)$	28.2191	23.2248	16.6132	12.4305	5.9299

and strictly prefers taxes if the inequality is reversed. Equation (16) indicates that there are potentially two groups of individuals who may prefer fees to taxes, one group of non-subscribers and one group of subscribers. For convenience, let us define these two groups in the following way.

DEFINITION 1: *Group 1 individuals are non-subscribers under the equilibrium fee and experience a net utility loss (relative to their endowment) under the equilibrium tax, that is,*

$$m_0 > m_0 - s^e + \theta v(G(s^e)) \tag{17}$$

and

$$m_0 \geq m_0 - t^e + \theta v(G(t^e)). \tag{18}$$

DEFINITION 2: *Group 2 individuals are subscribers under the equilibrium fee who also receive greater utility under fee-based provision than under tax-based provision, that is,*

$$m_0 - s^e + \theta v(G(s^e)) \geq m_0 \tag{19}$$

and

$$m_0 - s^e + \theta v(G(s^e)) \geq m_0 - t^e + \theta v(G(t^e)). \tag{20}$$

Table 2 summarizes the four possible outcomes to Stage 2 in terms of the relative levels of the equilibrium tax and fee, and the corresponding public good levels.[11] The table also characterizes Groups 1 and 2 and summarizes our observations of each case in the numerical simulations. Table 3 presents the policy voting results from the numerical simulations.

The simplest case is Case 1. Everyone subscribes under the fee and the outcomes under fees and taxes are, in all practical respects, identical. Everyone is indifferent between taxes and fees. The fact that a tax is technically mandatory while a fee is not is irrelevant when everyone subscribes voluntarily. This result occurs when the population is sufficiently homogeneous so that no one opts out at the equilibrium voting fee. Although interesting, this case is much more straightforward than the others, and no simulations are necessary. In the numerical simulations, we guarantee that some individuals opt out at the equilibrium voting fee by setting $\underline{\theta} = 0$. Thus, our simulations correspond to the last three cases from Table 2.

[11]Under the current formulation of the model, it is not possible that an equilibrium fee is smaller than the equilibrium tax, but provides at least as much public good. This is because the set of subscribers under the fee can be no greater than the entire population, which pays the tax. This case could occur, for example, if collection costs differ and are significantly greater for taxes than fees.

Table 2: Policy equilibrium conditions and characteristics

Case	**(1)**	**(2)**	**(3)**	**(4)**
Outcome to Stage 2	$s^e = t^e$ $G(s^e) = G(t^e)$	$s^e > t^e$ $G(s^e) \leq G(t^e)$	$s^e > t^e$ $G(s^e) > G(t^e)$	$s^e < t^e$ $G(s^e) < G(t^e)$
Group 1*	Do not exist (everyone subscribes)	May exist and are characterized by types with $\theta < \frac{t^e}{v(G(t^e))}$	May exist and are characterized by types with $\theta < \frac{t^e}{v(G(t^e))}$	May exist and are characterized by types with $\theta < \frac{t^e}{v(G(t^e))}$
Group 2**	Do not exist (everyone has equal utility under tax and fee)	Do not exist (all subscribers under fees prefer taxes—taxes provide more good at lower cost)	May exist and are characterized by types with $\theta \geq \frac{s^e - t^e}{v(G(s^e)) - v(G(t^e))}$	May exist and are characterized by types with $\theta \leq \frac{s^e - t^e}{v(G(s^e)) - v(G(t^e))}$
Simulations	Observed when $\underline{\theta}$ is sufficiently close to $\bar{\theta}$ (i.e., a sufficiently homogeneous population)	Observed for left skewed and uniform distributions of preferences, provided population is sufficiently heterogeneous	Observed for sufficiently right-skewed distributions of preferences, provided population is sufficiently heterogeneous	Not observed in simulations
Conclusions	Tax and fee financing are identical	Unlikely that fees defeat taxes	Fees may defeat taxes; some high-preference individuals may vote for fees together with low-preference individuals	Fees may defeat taxes; some middle preference individuals may vote for fees together with low-preference individuals

*Group 1 individuals are, by definition, non-subscribers under the equilibrium fee who would receive disutility from the equilibrium tax.

**Group 2 individuals are, by definition, subscribers under the equilibrium fee who receive greater utility under the equilibrium fee than under the equilibrium tax.

Table 3: Equilibrium policy outcomes

Simulation	Left Skewed	Uniform	Right Skewed	Right Skewed	Right Skewed
Parameter Values	$\gamma = -0.6$	$\gamma = 0$	$\gamma = 2$	$\gamma = 8$	$\gamma = 18$
Group 1 Condition	$\theta \leq 8.45$	$\theta \leq 7.07$	$\theta \leq 5.00$	$\theta \leq 3.16$	$\theta \leq 2.23$
% in Group 1	5.92	7.07	10.00	15.81	22.36
Group 2 Condition	NA	NA	$\theta \geq 118.02$	$\theta \geq 30.33$	$\theta \geq 33.46$
% in Group 2	0.00	0.00	0.00	38.71	35.02
% Vote for fee	5.92	7.07	10.00	54.52	57.38
Equilibrium Policy	TAX	TAX	TAX	FEE	FEE

In Cases 2, 3, and 4, some low-preference individuals are likely to receive disutility from the equilibrium voting tax, and thus these individuals (Group 1) will prefer fees to taxes. If the equilibrium voting fee is higher than the equilibrium tax, but provides no greater public good (as in Case 2), then all subscribers under fees would prefer taxes to fees. This outcome is depicted in Figure 3. Notice that no Group 2 individuals exist in Figure 3 or in the simulations with left skewed or uniform distributions of preferences, as the tax provides more public good at a lower cost relative to fees. We also find that taxes are the policy equilibrium in each of these cases, as shown in Table 3.

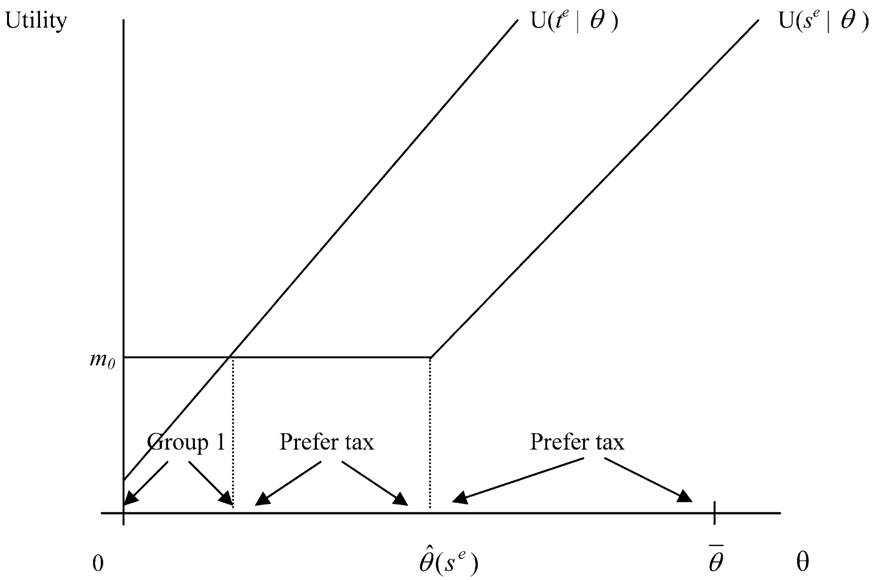

Figure 3: Case 2: $s^e > t^e$ and $G(s^e) \leq G(t^e)$

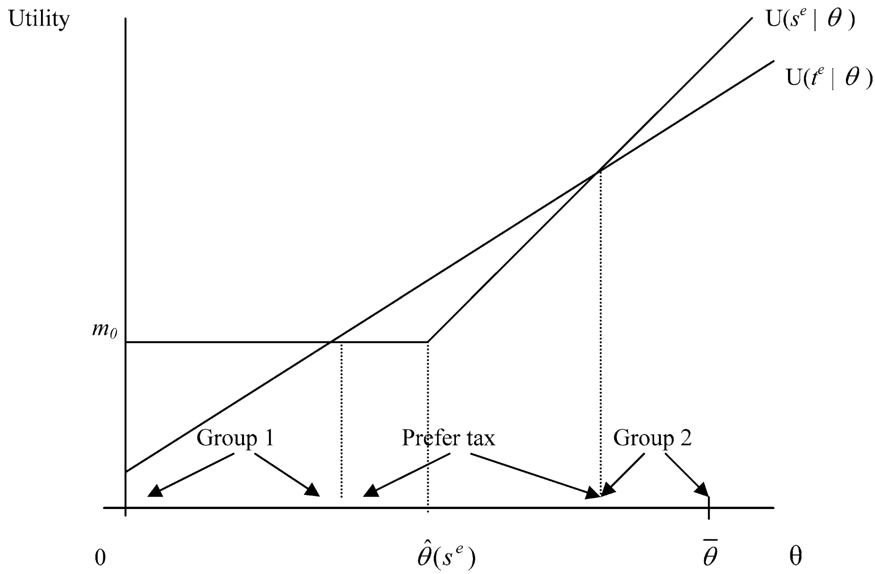

Figure 4: Case 3: $s^e > t^e$ and $G(s^e) > G(t^e)$

Taxes are also preferred to fees with a very moderately right-skewed distribution of preferences, despite the fact that the equilibrium fee, though higher, also provides slightly more public good. However, when preferences are significantly right skewed, we observe that the equilibrium voting fee is higher than the equilibrium tax and provides a significantly higher level of public good (Case 3). Some subscribers with sufficiently high preferences, therefore, prefer fees to taxes, as depicted in Figure 4. In our two most right-skewed simulations, we find that fees receive majority support and are chosen over taxes, as shown in Table 3.

We did not observe Case 4 appearing in any of our simulations. That is, in each of the simulations in which some individuals opt out, we find that the equilibrium fee is higher than the equilibrium tax. This can be attributed to the fact that, as stated earlier, high-preference individuals face less resistance from below to increases in a fee than increases in a tax. Furthermore, in order to compensate for the smaller subscription set, high-preference individuals have most preferred fees that are likely to exceed their most preferred taxes.

Before we proceed, it is interesting to note that the coalition of individuals preferring fees to taxes can include individuals with a variety of different preferences depending on the outcome to Stage 2 of the game. When taxes provide more of the public good, we may have low and middle types preferring fees, with high types preferring taxes. However, when fees provide more of the good we can have low and high types preferring fees, with middle types preferring taxes, an "ends against the middle" result similar to Epple and Romano (1996).

Although not the focus of the current analysis, we also performed welfare comparisons to see which policies provide higher utilitarian social welfare. We compared four policies: an optimal lump sum tax, an optimal fee, a voting equilibrium tax, and a voting equilibrium fee, where "optimal" refers to the result of maximizing an additive social welfare function. Consistent with the results in Fraser (1996), the optimal tax provides the highest level of social welfare in all of our simulations. More important, however, are the relative welfare rankings of the remaining three policies. In the scenario with the most left-skewed preferences, which is the case where the policy choice is the tax regime, the equilibrium voting tax provides the next highest level of social welfare, followed by the optimal fee and voting fee, in that order. In the second case with a simple uniform (unskewed) distribution of preferences, the optimal and voting taxes are identical and, therefore, provide identical levels of social welfare. Similarly, the optimal and voting fees are identical, but provide a level of social welfare below that of the two tax regimes.

The three right-skewed simulations provide the most interesting results. In the least right-skewed case the rankings again are optimal tax, voting tax, optimal fee, and voting fee, in that order. However, for the last two simulations when the right skewness is more extreme, the voting tax falls from second-best to fourth-best. In both cases, welfare under the voting fee exceeds that of the voting tax. Furthermore, as demonstrated above, a voting majority is also likely to prefer a fee to a tax in both cases. Our normative results suggest that while in general political outcomes are not optimal (with the exception of the uniform (unskewed) distribution), they seem to be "second-best" in the sense of being the second-highest outcome of the possible four.

5. Conclusions

Previous analyses of alternative methods of providing excludable public goods focus either on social welfare maximization or on profit maximization. Potential consumers are confronted with a tax or fee level that is determined by some means other than a democratic political process. However, when the public good in question is being provided by the state or some other form of representative government, it becomes necessary to consider the mechanisms and forces that are likely to impact how and at what level the good is provided. These are, namely, the political process and the preferences of individual voters in the population. To the extent that majority-rule voting provides a reasonable approximation of the decision-making process for many goods that are publicly provided, the results from our model have important implications for a wide range of goods from recreation to education.

The model demonstrates that, under majority-rule voting, the distribution of preferences for a public good is critical both in determining the level of provision under tax and fee alternatives, and in determining the policy preferred by the majority of individuals. Although the individual with the median preferences determines the equilibrium tax, an individual with preferences stronger than the median generally determines the equilibrium fee, when one exists. When preferences are distributed uniformly or are left skewed, the majority of individuals prefer tax-based provision. Uniform and left-skewed distributions of preferences are also consistent with higher public good provision and higher social welfare under taxes. However, when preferences are right skewed, the majority may prefer fee-based provision. Furthermore, the level of provision of the public good, as well as social welfare, may actually be *higher* under fees than under taxes in the latter case.

We made several assumptions that should be reconsidered in future research. For example, we assumed that individuals differ in preferences, but have identical incomes. Introducing heterogeneous incomes does not matter in the present model because taxes are uniform and utility is linear in m; hence, the size of the endowment does not affect individual preferences over the level of a tax or fee. Alternative formulations of the model would be to assume a different utility function and have heterogeneous endowments. Individual tax contributions could also be made to vary with income, such as with a proportional income tax. It would be interesting to see whether our findings are robust to these changes.

We also do not allow for simultaneous tax and fee payment. Many real-world examples of excludable public good provision, such as the U.S. National Park System, involve tax financing supplemented by user fees. Incorporating this possibility would be an interesting extension to the model presented here both from a positive and a normative standpoint.

It is also worth emphasizing that the model assumes no externalities from the public good; non-subscribers are perfectly excluded and receive no utility from the public good. Clearly, many public goods have both excludable and non-excludable characteristics. For example, Yellowstone National Park is valued by park visitors because of the variety of camping, hiking, and sight-seeing opportunities they can enjoy. However, the park is arguably valued by many non-visitors for its mere "existence." For the present purposes, we define the public good in question more narrowly; we include only those aspects of the good that benefit subscribers. Another interesting extension would be to allow for congestion externalities. In this case, we suspect that the fee regime becomes even more attractive because the fee serves an important function to limit congestion.

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