Chapter 29

LOCAL PUBLIC GOODS AND CLUBS*

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Contents

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Abstract

I discuss recent contributions to the theory of group formation and the provision of jointly consumed public goods and services. I highlight the distinction between models of pure group formation, and models where the formation of groups and the sharing of public goods are constrained by a division of geographic space into jurisdictions. Much of the literature concerns the distortions that arise when price systems or tax systems are constrained, for example, to serve the dual roles of redistributing income and funding public services. I also highlight the distortions that can arise from arbitrary divisions of space, and review recent contributions that emphasize the distortions that arise when there are both public and private providers of services. My focus is mainly on equilibrium concepts and policy instruments.

Keywords

clubs, local public goods, capitalization, externalities

JEL classification: H0, H4, H7

1. Introduction

Local public economics is a large subject, which warrants more than one review. In this review, I discuss theories of group formation, financing of local public goods, incentives to provide them efficiently, the role of geography in constraining the formation of groups, and the distortions that arise when shared services are provided by both public and private providers. I try to concentrate on how the subject has developed since reviews in previous *Handbooks*. The expository technique is to illuminate ideas through examples, which will hopefully be useful for introductory courses. Many important topics are left out, such as empirical findings and fiscal federalism.

Theories of group formation have bifurcated into "club theory", which concerns nonspatial group formation, and "local public goods", which blends group formation with geography and sometimes with voting mechanisms. I begin in Section 2 with club theory because it is a simpler economic context, and creates a benchmark against which to measure the complexities introduced by geography and restrictions on pricing created by public policy concerns. In all of what follows, I try to emphasize the complexities introduced by heterogeneity, since previous surveys have mostly assumed that agents are alike.

Section 3 addresses what is perhaps the most studied equilibrium concept for local public goods, namely, free mobility with majority voting on local public goods. Section 4 focuses on funding and the fact that consumption of local public goods is coupled with the consumption of space. In fact, space can be coupled with the consumption of many different local public goods, and also with employment opportunities. This bundling creates enormous complexity.

Section 5 describes some new ideas regarding the interaction of private and public institutions for providing public goods, and Section 6 concludes with some "orphan" ideas that do not fit easily elsewhere.

The later Sections 3–6 are probably the most useful ones in pointing graduate students to open questions.

2. Club economies

Club models are models of group formation. Because clubs are not identified with geographic space or with occupancy of land, they are hard to interpret as "jurisdictions". My own view is that club theory is a branch of general equilibrium theory more than a branch of public finance, although traditionally treated there. Shared goods such as schools and libraries easily fit the club model. The thrust of club theory is that the competitive market will function efficiently to provide club goods, so there is no reason that such goods should be publicly provided at all. I return to this issue below.

The basic notion of club economies is that agents form groups to confer externalities on each other. The main source of these externalities in the original Buchanan (1965) paper are public services. Buchanan assumes that agents band together to share the cost of (excludable) public goods. Optimal sharing groups are bounded in size because of a second externality, crowding. While a large membership reduces the per capita cost of the public services, large membership also increases crowding costs. Tiebout (1956) assumes that optimal sharing groups are bounded in size due to the cost structure of producing the public services. Modern theories incorporate both aspects. The key premise is that for sufficiently large groups, the crowding costs or increased cost of provision dominate the benefits of sharing the costs of public services. Consequently, large groups cannot improve on what is achievable by small groups in providing public services, and this is why the models have been interpreted as models of "local" public goods.

Club models have been analyzed according to various equilibrium concepts, each of which has some resemblance to the "real world". Since equilibrium concepts govern allocative outcomes, I begin by describing some important equilibrium concepts, using the Buchanan model. The Buchanan model assumes "anonymous" crowding, which means that the number of members of a club matters for the externalities they confer, but not the members' characteristics. After discussing the equilibrium concepts, I explain how Buchanan's ideas have been modified to include the notion that agents with different characteristics confer different externalities, and how complementarities between private goods and club goods affect the conclusions about optimal group formation.

2.1. Equilibrium concepts

Following Buchanan (1965), assume that everyone is alike, with utility represented by $U(x, n, \gamma)$, where $x \in \Re_+$ is the amount of a single private good consumed, n is the size of the sharing group, and $\gamma \in \Gamma$ represents the public services in the club. Letting $c(n, \gamma) \in \Re_+$ represent the cost of the public services and w the per-capita endowment of the private good, the per-capita utility available in a club of size n is

$$\upsilon(n) \equiv \max_{\gamma \in \Gamma} U\left(w - \frac{c(n, \gamma)}{n}, n, \gamma\right). \tag{1}$$

Let the maximizer on the right-hand side be $\gamma^*(n)$. The basic assumption of club theory is that the maximizer of $\upsilon(n)$, say n^*, is finite.

The main equilibrium concepts that have been applied to this model are the core, competitive equilibrium, Nash equilibrium and free mobility equilibrium. The "definitions" given here are very informal, hopefully without causing confusion. For the complete treatments, the reader should consult the original texts.

The core: In this equilibrium notion, which was introduced to the study of club economies by Pauly (1967, 1970a,b), agents act cooperatively to maximize their utility. An allocation is in the "core" of a club economy if no group of agents can make themselves better off using only their own endowments. Provided the economy is larger than n^*, an allocation in the core must have the equal-treatment property: all agents must receive the same utility, namely, $\upsilon(n^*)$, since otherwise a low-utility agent could bribe members of a club to let him replace a high-utility agent. Letting N represent the number of agents in the economy, clubs of type $(\hat{\gamma}, \hat{n})$ can only be part of a core allocation if it holds that

$$U\left(w - \frac{c(n,\gamma)}{n}, n, \gamma\right) \leqslant U\left(w - \frac{c(\hat{n},\hat{\gamma})}{\hat{n}}, \hat{n}, \hat{\gamma}\right) \equiv \upsilon(\hat{n}) \quad \text{for all } (n,\gamma) \text{ such that } \gamma \in \Gamma, n \leqslant N. \tag{2}$$

Pauly's main observations were that club allocations in the core are efficient, but that the core is typically empty. Club formation will be unstable in the sense that some group of agents will typically have an incentive to form a new group. In this simple case, the agents who are in a group smaller than n^* can "bribe" some of the other agents to join them, in order to form a group of size n^*.

One might hope that stability would be restored if group formation is slightly costly. At least two notions of "approximate" core have been used to address this question. The weak-ε core, due to Shapley and Shubik (1966), is a notion of stability under which no group of agents has an incentive to defect into a new group if they must pay ε per member to do so. The fat-ε core, due to Anderson (1985), is a similar notion under which a defecting group must pay ε times the number of agents in the economy rather than in the group. Under certain restrictive conditions, the weak-ε core has been shown to be nonempty in large games [e.g., Wooders (1980, 1988)]. A (somewhat incomplete) intuition is as follows. In a large economy, most agents can be accommodated in optimal groups, but there will be a few leftovers. In the example above, then regardless of how large the economy is, there are fewer than n^* agents who cannot be accommodated in optimal groups. The agents in optimal groups can be taxed in order to compensate the leftovers, in order to equalize utilities. If the economy is large, the burden on each member of an optimal group will be small, and the equalized utilities will be close to the maximum that is achievable in optimal groups. Further, if there is a small cost of forming a new group, this situation may be stable. There is only a small benefit to forming a new group, and there is a cost of doing so. It the cost is greater than the benefit, the allocation of agents to groups is stable.

However, the argument depends on restrictive conditions. For one thing, the argument is mainly for economies with "types" of agents, and it is not clear how to extend it. Second, restrictive conditions on preferences are required in order to ensure the compensations can be made. One condition that has been used is that utility is "transferable". Another is Mas-Colell's (1975, 1980) assumption that private goods are "essential", which has been used in many economic contexts with indivisible choices. It is a very strong assumption [1]. For more general economies, such transfers may be

[1] The assumption has many names. For a discussion of what it means and how it has been named, see Gilles and Scotchmer (1997, p. 365).

impossible, and the weak-ε core can be empty for small ε, no matter how large the economy; see Example 5.2 of Ellickson, Grodal, Scotchmer and Zame (EGSZ, 2001). In light of the example, EGSZ show nonemptiness of the Anderson fat-ε core instead of the weak-ε core. Their Theorem 4.3 on nonemptiness of approximate cores in large economies gets away from the notion that agents' preferences are drawn from a finite set of "types", and avoids the restrictive assumptions on preferences listed here.

I do not focus on notions of approximate stability because they have not been imported to models where consumption of "local public goods" is tied to geography. They are models of pure group formation, and they are related to a larger literature on nonemptiness of the core in large games and economies, which I do not review here.

Competitive equilibrium: A second strand of inquiry is whether memberships in clubs can be thought of as commodities like any other privately traded commodities, and whether an allocation can be thought of as governed by prices. Unlike, say, Lindahl equilibrium, it is not public goods *per se* that are bought and sold in the market, but rather *memberships in groups.* The groups in which memberships are sold can commit to certain public services, and possibly to a certain profile of other members. The tricky issue is how to define the commodity space and price system. Key features of a price-taking equilibrium are that (i) the commodity space is defined independently of the set of agents, (ii) the price system is complete with respect to the set of commodities, (iii) prices are anonymous, and (iv) agents optimize with respect to the price system, but not by observing other agents' preferences or endowments[2]. Of course, the idea of a price-taking equilibrium is rather far afield from the way local public economies operate, and this is why I consider club theory to be a motivator for the subject of local public economics, but not the subject itself[3].

For the Buchanan economy, the commodity space would be memberships in clubs of all types $(\gamma, n) \in \Gamma \times Z_+$ and the membership prices would be

[2] The competitive conjecture has a very long history for club economies, although not initially formulated as here. These features were introduced to club economies by Scotchmer and Wooders (1987a; see also 1987b), and clubs are fully integrated into general equilibrium by Ellickson, Grodal, Scotchmer and Zame (EGSZ) (1999a,b, 2001), e.g., getting away from the restrictive notion that there are "types" of preferences. Previous notions of equilibrium lack at least some of the listed features, and many use notions related to "utility-taking", where decision makers are assumed to observe aspects of agents' indifferent maps instead of a price system. Previous contributors to the competitive model include Stiglitz (1977), Boadway (1982), Berglas (1976a,b, 1984), Bewley (1981), Brueckner and Lee (1989, 1991), Wooders (1978, 1981, 1980, 1989), Berglas and Pines (1981), Brueckner (1994), Scotchmer (1997) and Conley and Wooders (1997). As in Scotchmer and Wooders (1987a), some of the later papers emphasize the need for anonymous prices. Ellickson (1979) described a true competitive equilibrium, although not in a model with externalities among club members. There is also a long history of club models with Lindahl prices [recently, Conley and Wooders (1998) and Wooders (1997)], but since I view Lindahl prices as unconvincing, I do not discuss them.

[3] The club model has many other applications. For example, a firm or academic department is a group that is governed by prices. For most such applications, the model below with heterogeneous crowding is apt. See Ellickson, Grodal, Scotchmer and Zame (1999b) for how clubs can be interpreted as firm formation, school formation, etc.

$\{q(\gamma, n) \in \Re\colon (\gamma, n) \in \Gamma \times Z_+\}$. A formal definition of competitive equilibrium, extending to a much broader class of club economies, can be found in Ellickson, Grodal, Scotchmer and Zame (1999a). The main requirements, in addition to feasibility, are that (i) every potential club makes nonnegative profit, and clubs in equilibrium make zero profit, and (ii) no agent can improve his utility by joining a different combination of clubs.

To illustrate this idea in the Buchanan context, assume for simplicity that all clubs in equilibrium are of the same type, say (γ^*, n^*), as will be true if there are unique maximizers of Equation (1). The equilibrium conditions require that for all $(\gamma, n) \in \Gamma \times Z_+$

$$nq(\gamma, n) - c(\gamma, n) \leqslant 0 \text{ with strict equality for } (\gamma^*, n^*)$$
$$U(w - q(\gamma, n), n, \gamma) \leqslant U(w - q(\gamma^*, n^*), n^*, \gamma^*).$$

It follows that Equation (2) holds, so that if an equilibrium allocation exists, it is in the core. In fact something stronger is true: provided the economy is larger than n^*, every allocation in the core is a competitive equilibrium. In this sense, the small-groups assumption that n^* is finite seems to lead to the conclusion of core/competitive equivalence. Cooperative and competitive behavior lead to the same outcome, at least when there is only one private good. (But see Example 4 below.)

Because of core/competitive equivalence, the existence problem that Pauly identified for the core carries over to competitive equilibrium. If the population is not an integer multiple of n^*, competitive equilibrium does not exist, and the core is empty. Ellickson, Grodal, Scotchmer and Zame (1999a) solve this problem by assuming that there is a continuum of agents.

Nash equilibrium: A consequence of the fact that the economy is finite is that clubs will not be perfectly competitive. As in industrial organization, one can study profit-motivated club formation in an oligopoly rather than assuming perfect competition. Suppose, for example, that the firms' strategies are the public services provided by the club and the membership price, namely, (γ, q). In Nash equilibrium, services will be provided efficiently within each club (since that enhances the value of memberships, which can be extracted through price), and the price will determine the number of members. By analogy with Bertrand competition in markets for private goods, one might have thought that price competition would lead to competitive prices. However there is an important difference, namely, that the club's quality is endogenous to the price. Lowering the price degrades quality by attracting more members and adding to congestion. As a consequence, a club does not get the whole market even if it has the lowest price and the most attractive services. In fact, equilibrium prices will typically be higher than the competitive price, although they converge to the competitive price (in a two-stage game of entry) in large populations [Scotchmer (1985a,b)].

The nature of Nash Equilibrium depends on what the strategies are, and also on the objective function. The economic question behind choice of strategies is "What does the jurisdiction manager think the other jurisdictions will hold fixed when his own policy changes?" In club economies it might be natural to take as fixed the prices and services offered in other clubs, as above, and to assume that the manager maximizes profits. But in local public goods economies, both the strategies and objective function are less obvious. For institutional reasons, budgets within local jurisdictions might have to be balanced, so the objective could not be to maximize profit. With a balanced budget, migration to or from a jurisdiction due to another jurisdiction's change in policies will necessitate a change in either taxes or expenditures. In that case, the Nash equilibrium will depend on which of those two variables, taxes or expenditures, is thought to be held constant when a single jurisdiction changes its policies. Such issues are explored by Wildasin (1988) [4].

Free mobility equilibrium: Tiebout (1956) conjectured that if agents can "vote with their feet", they will find the jurisdictions that best satisfy their tastes, and that this should be a strong force toward efficiency. The idea of free mobility lies at the heart of a large literature, and I devote the next section to it. The basic notion is that a partition of agents into jurisdictions is stable if no agent wants to move. Any agent has a right to move to any existing jurisdiction. Freedom to migrate is constitutionally guaranteed in many Western democracies, and that is why the equilibrium concept is of interest.

The free-mobility notion does not permit the kind of coordinated deviations that motivate the "core" concept, and it does not permit an entrepreneur to assemble a new jurisdiction simply by announcing the type of club he will provide (public services and memberships), and then admitting members according to the price system, as the competitive concept does. The options for creating a new type of jurisdiction are correspondingly limited, with consequences that can be seen by applying the free mobility notion to Buchanan clubs [5].

In general, a definition of a free mobility equilibrium must include a rule that establishes how the public services will be decided in each jurisdiction. However, in the simple Buchanan model, all agents are alike, and will agree on the best provision of public services once the jurisdiction is formed. Assume, therefore, that for each n, a group of size n will choose the efficient public services $\gamma(n)$, and will fund them with equal cost shares.

Suppose that the per-capita utility function υ is strictly quasiconcave and single peaked, so that there is a unique utility-maximizing size n^*, and suppose that there are more agents than $2n^*$. I argue that jurisdictions will typically be larger than the efficient size n^* even if an unlimited number of jurisdictions are possible, and may be arbitrarily large. This is in contrast to what happens under the other equilibrium concepts discussed above.

[4] Other variants on Nash equilibrium have been studied as well. For example, Barham, Boadway, Marchand and Pestieau (1997) show that noncontractual contributions of effort in producing a club good will be suboptimal. To mitigate this problem, club sizes in equilibrium will also be suboptimal relative to the case that effort levels are contractual. See also Cremer, Marchand and Pestieau (1997), Konishi, LeBreton and Weber (1997), and Boadway, Pestieau and Wildasin (1989).

[5] The following discussion follows Jehiel and Scotchmer (1993).

We can characterize the free mobility equilibrium by the numbers of members in different jurisdictions, say $n_1, n_2, \ldots$ By free mobility, it cannot be the case for any two jurisdictions i, j, that $v(n_j) < v(n_i + 1)$, since a member of jurisdiction j would move to i. Thus, no two jurisdictions i, j can satisfy $n_i \leqslant n_j < n^*$. If two jurisdictions are both smaller than the utility-maximizing size, then a migrant from the smaller jurisdiction to the larger one can improve both his own utility and that of the other members. Thus, at most one jurisdiction can be smaller than the utility-maximizing size n^*. Further, if for any $\hat{n} \geqslant n^*$ it is possible to partition the agents so that each group is of size $\hat{n}$ or $\hat{n} + 1$, then the partition is a free-mobility equilibrium. Thus, free mobility often leads to jurisdictions that are larger than efficient. This is in contrast to the core or competitive equilibrium, which have the property that, if equilibrium exists, it is efficient. The difference arises from the fact that, in free mobility equilibrium, only unilateral actions are permitted. There is no opportunity, either explicitly as in the core, or implicitly as in competitive equilibrium, for a group of agents to make a coordinated decision to reassemble in an efficient size group.

Randomized memberships: Cole and Prescott (1997) have proposed an equilibrium concept in which agents are allowed to randomize on club memberships. Since they emphasize heterogeneous crowding, and since it is hard to illustrate the concept in the Buchanan model, the concept is illustrated in the next subsection.

2.2. Heterogeneous crowding

Anonymous crowding means that members of a club care how many other members there are, but do not care about the members' characteristics. However, in most group situations, participants impose different externalities according to characteristics such as productive skills, niceness, whether they smoke, and how educated they are[6]. An important example arises in schools, discussed below, where there may be peer effects. A student's behavior, abilities or resources can all confer externalities on other students.

The competitive theory described above for club economies with anonymous crowding extends to club economies with heterogeneous crowding, but heterogeneity compounds the problems of existence. In the model with anonymous crowding, an

[6] Heterogeneous crowding was introduced to the club model by Berglas (1976b). Other contributors include Stiglitz (1983), Scotchmer and Wooders (1987b), Brueckner and Lee (1989), Wooders (1989), McGuire (1991), Brueckner (1994), Epple and Romano (1996a,b,c), Engl and Scotchmer (1996), Gilles and Scotchmer (1997), Oates and Schwab (1991), Scotchmer (1997), Cole and Prescott (1997), Conley and Wooders (1997, 2001) and Ellickson, Grodal, Scotchmer and Zame (1999a,b, 2001). Except for the latter, these models are still restricted to "types" of preferences. Benabou (1993) introduces the idea that agents invest in their external characteristics, which then earn a market return. See also Ellickson, Grodal, Scotchmer and Zame (1999b), who show that clubs can be interpreted as firms and schools, and show how skills acquisition interacts with the set of club (firm) technologies that are available. Helsley and Strange (2000b) introduce the notion that externalities are generated by the agents' actions, which are chosen rather than endowed.

existence problem arises because of scale effects. The population size might not be a multiple of the optimal "small group". Example 1 shows that, when it is efficient to group agents with different external characteristics, the existence problem has another dimension. Even if there are no scale effects defining the optimal size of a group, it might be impossible to match people in groups with the most preferred combinations of characteristics.

Example 1. *The existence problem with heterogeneous crowding*: Suppose the population has equal numbers of two types of agents, type-G and type-B. Suppose that each agent must belong to exactly one club, and preferences are described by $U_B(b,x)$, $U_G(b,x)$, where x is consumption of private good, and b is the ratio of type-B to type-G in the club:

$$
\begin{aligned}
&U_B(2,x) = x + 1,\\
&U_B(b,x) = x \qquad \text{if } b \neq 2,\\
&U_G(\tfrac{1}{2},x) = x + 1,\\
&U_G(b,x) = x \qquad \text{if } b \neq \tfrac{1}{2}.
\end{aligned}
$$

Thus, type-B agents prefer a club with a preponderance (ratio 2 to 1) of type-B agents, and type-G prefers a preponderance (ratio 2 to 1) of type-G agents.

The example is designed without scale effects. Unlike the existence problem illustrated above for anonymous crowding, utility is not affected by the size of the club, but only by the composition of its membership, the ratio of type-B to type-G. The problem with existence will not arise because of crowding costs and the requirement that each club be a particular optimal size, but because the agents' preferences on composition cannot be accommodated with the relative numbers of people in the population.

Since utilities are quasi-linear, an efficient (or competitive) allocation maximizes total utility. This is accomplished by putting half the people in clubs with composition $b = 2$ (such clubs include 2/3 of the type-B people and 1/3 of the type-G people) and by putting the other half in clubs with composition $b = \frac{1}{2}$ (such clubs include 1/3 of the type-B people and 2/3 of the type-G people). Thus, $\frac{2}{3}$ of the people are in their most preferred clubs.

Equilibrium will not exist unless it is possible to put all the people in the two optimal types of clubs in these proportions. This is where the existence problem lies. If, for example, there are 5 people of each type, it will not be possible to partition the population into clubs of the two types, since 2/3 of 5 is not an integer. Notice that if the population were a continuum instead of finite, the existence problem is overcome. The total "number" of type-B people in clubs with composition $b = 2$ would be, for example, $\frac{10}{3}$. ■

Because of both the integer problem and the problem of accommodating a finite group of agents consistently in "optimal" clubs, the core will typically be empty in any finite club economy, and competitive equilibrium will not exist.

As mentioned above, the idea that club memberships should be treated like other commodities in general equilibrium has a long history. However, club formation could not be integrated into general equilibrium theory until it was understood how to solve the problem of ensuring that agents' choices as to memberships were "consistent" with each other. That problem was solved by Ellickson, Grodal, Scotchmer and Zame (1999a, 2001). There is a finite set Ω of possible external characteristics (such as helpfulness, intelligence, skills), and an agent a is endowed with characteristics $\omega_a \in \Omega$ as well as private goods. Each possible club type specifies the numbers of members with the different characteristics, which is modeled as a vector π, as well as (possibly) a costly activity or shared facility, which is modeled as a choice γ from an abstract set Γ. The consistency problem is to ensure that, whenever some agent wants to belong to a particular clubtype, there are other agents wanting to fill the other places in that club type. Ellickson, Grodal, Scotchmer and Zame (1999a) solve this problem with a continuum of agents. They show that equilibrium exists, is efficient, and, in fact, coincides with the core.

The existence problem still arises with a finite number of agents, as in the above example. In fact, the problem is much deeper than illustrated in the example. In the example, it is clear at the outset what the optimal or "chosen" club types will be. In general, there will be a large set of possible club types, and the ones that are chosen in equilibrium will depend on endowments of private goods and on agents' preferences, which will typically be different for all agents. Nevertheless, Ellickson, Grodal, Scotchmer and Zame (2001) show that in a large, finite club economy, the fat-ε core is nonempty (see above); and the core can "almost" be decentralized as an equilibrium. Ellickson, Grodal, Scotchmer and Zame (1999b) show how these papers can very simply be extended so that membership characteristics can be chosen instead of endowed, which makes it natural to interpret characteristics as skills, as in Benabou (1993), and to interpret the club model as a model of firm formation or school formation. The Ellickson, Grodal, Scotchmer and Zame (EGSZ) papers are more in the spirit of general equilibrium theory than previous models of clubs, in that they avoid the assumption that agents' preferences are drawn from a finite set of "types". In addition, they permit memberships in several clubs simultaneously [7].

Following the main premise of club theory, the competitive foundation of the EGSZ model is that clubs are small. The expression of this assumption is that there is an exogenously given set of "club types", each one defined by its public services and the external characteristics of its members, all bounded in size [8]. The membership

[7] This seemingly small change necessitates a revision of analytical techniques. The decentralization arguments of previous authors, e.g., Gilles and Scotchmer (1997), used a two-part construction of prices. After constructing the private goods prices, membership prices were constructed as willingness-to-pay. This technique does not extend in any obvious way to multiple memberships.

[8] For Buchanan clubs, the efficiency of small groups arises as a consequence of congestion. Club papers with heterogeneous crowding tend to make the assumption more primitive, e.g., Scotchmer and Wooders (1987b) and Conley and Wooders (1997) restrict attention to clubs that are bounded in size.

prices have the form $q(\omega,(\pi,\gamma))$, where ω is the member's external characteristic, and (π,γ) specifies the type of club. Such prices make sure that, in choosing their club memberships, agents account for the externalities they impose. Externalities can be positive or negative, and hence the admissions prices can be positive or negative, although some must be positive if there are resource costs to providing the public services within the club. Nevertheless, agents with very attractive external characteristics might be paid to join clubs. If prices could not depend on the external characteristics, equilibrium might not exist. This is illustrated in the next example.

Example 2. *Necessity of externality pricing*: Consider an economy with equal numbers of (B)ad students and (G)ood students. There is one private good, of which each student has 2 units endowment. A school has two students, and costs 2 units of the private good to run. All schools have two students, so a school can be GG, BG or BB. Preferences are described by

$$\begin{array}{ll} u_B(x;BB) = 4+x & u_B(x;BG) = 7+x \\ u_G(x;GG) = 6+x & u_G(x;BG) = 4+x \end{array}$$

The preferences reflect the fact that students receive positive externalities from good students. The externalities can be thought of as supplements to future income. The efficient allocation is for good students and bad students to share schools, in order to create these externalities. Write $q(\omega,BB)$, $q(\omega,GG)$, $q(\omega,BG)$ for the tuition prices paid by students with external characteristics $\omega = B,G$. A type-B consumer cannot join a type-GG club and vice versa.

At equilibrium, tuition must cover the cost of 2, hence $q(B,BB) = q(G,GG) = 1$. At these prices, bad students can obtain utility $2 - q(B,BB) + 4 = 5$ by choosing a homogeneous school with two bad students, and utility $2 - q(B,BG) + 7$ by choosing a mixed school with a good student. A good student can obtain utility $2 - q(G,GG) + 6 = 7$ by choosing a homogeneous school with two good students, and utility $2 - q(G,BG) + 4$ by choosing a mixed school with a bad student. In order that both students will prefer the mixed school, prices must satisfy $5 \leqslant 9 - q(B,BG)$ and $7 \leqslant 6 - q(G,BG)$. The price for good students must be negative, $q(G,BG) \leqslant -1$, in order to induce them to share a school with bad students. However, it is in the interest of the bad students to subsidize them, since the positive externalities they receive outweigh the subsidy. The bad students will pay a price $q(B,BG) \leqslant 4$, part of which will cover the resource cost of the school, and part of which will be a payment to good students. If the prices for good and bad students cannot differ, no equilibrium exists. Members of the mixed school would have to pay $q(B,BG) = q(G,BG) = 1$, the same prices as for homogeneous clubs. But then bad students prefer the mixed school BG, while good students prefer a homogeneous school GG. ■

Brueckner and Lee (1989) assume that only the relative numbers matter, and not the size. Ellickson, Grodal, Scotchmer and Zame assume that there is an exogenously given set of possible clubtypes. Since the set is finite, clubs are automatically bounded in size.

Cole and Prescott (1997) have criticized the above equilibrium concept as being inefficient. They point out that, in general, an equilibrium where agents randomize on memberships can increase expected utility. The following example illustrates their point, but of course it only applies if the utility function can be interpreted as a von Neumann–Morgenstern utility function[9].

Example 3. *Randomized memberships*: Suppose that there are two types of agents, G and B. There are twice as many B agents as G agents. There is only one type of club, consisting of one agent of each type. Type-G agents only care about private good consumption, but type-B agents receive more utility from their private good consumption when in a club. In particular, the utility of type-B is $f(x) + 1$ when in a club, where x is the consumption of private good, and $f(x)$ when not in a club. The function f is concave.

Assume that all agents have an endowment w of the private good. An equilibrium of the EGSZ type, with nonrandom memberships, has all the type-G agents matched in clubs, and half the type-B agents. The price of a type-B membership must be the q that solves $f(w - q) + 1 = f(w)$ in order that the excluded type-B agents are indifferent between membership and not. Since the club makes zero profit, type-G agents receive a subsidy of q from the type-B agents. That is, type-G agents pay a negative price of q. In this equilibrium type-G agents receive utility $w + q$ and type-B agents receive utility $f(w)$.

Now suppose instead that each type-B agent pays $q/2$ to flip a coin to establish whether he joins a club. Then type-G agents are equally well off (they still receive the subsidy of q), and type-B agents are better off *ex ante* because they receive expected utility $f(w - q/2) + 1/2$, which (using concavity of f) is greater than $(1/2)f(w) + (1/2)f(w - q) + 1/2 = f(w)$. Thus, randomization increases the expected utility of type-B agents *ex ante*, although they receive different utility *ex post*, depending on whether they receive club membership. ■

A limitation of the equilibrium concepts described above is that the externalities created by a club member do not depend on intensity of use. Variable use is discussed in Berglas (1981), Scotchmer (1985b) and Scotchmer and Wooders (1987a) for the case of anonymous crowding. (Also see Example 10 below on p. 2028.)

2.3. Trade in private goods

The sufficiency of small groups for providing utility is the basis for a competitive theory of club formation in both the Buchanan model and its extensions to

[9] Randomization does not solve the existence problem in finite club economies, but is purely a tool to increase expected utility. In the full model, the consumer must randomize on the entire consumption bundle, including private goods and club memberships. Cole and Prescott (1997) point out that an equivalent randomization on wealth would work, but the particular randomization depends on the prices of private goods, so the randomization on wealth presupposes the later equilibrium on clubs and private goods.

heterogeneous crowding. However, the competitive theory of clubs has more in common with general equilibrium theory than is apparent from the above discussion. In particular, if private goods are traded by agents in different clubs, the equivalence between the core and competitive outcomes, as exposited above for Buchanan clubs, no longer holds in finite economies. This is because clubs are no longer self-contained, isolated units in the economy. Clubs are linked to other clubs through trade. Such linkage has an interesting implication. If club memberships have an impact on demand for private goods, then club formation can change the terms of trade in the economy. In fact, club membership can create gains to trade that otherwise would not exist, thus improving utility opportunities, and that can be a motivation for club formation.

The latter point is illustrated by Example 4. All agents are assumed to be alike, as in a Buchanan economy, but there are two private goods. If all agents belonged to the same type of club, as in a Buchanan economy, there would be no opportunity for trade. In the example, however, the agents' demands for private goods depend on their club memberships. In order to profit from trade, they form clubs that alter their demands for private goods. Even though the example has the club feature that only small groups are efficient (in fact all clubs are size 1 or 2), the core/competitive equivalence exposited above for the case of a single private good no longer holds.

Example 4. *How trade in private goods matters*: Suppose there are no public goods, that each agent is endowed with one unit of each of two private goods, and club membership affects the demands for private goods as follows.

$$\begin{aligned} U(x,n) &= x_1 + x_2 && \text{if } n = 2, \\ U(x,n) &= \sqrt{2}x_1 + \tfrac{1}{2}x_2 && \text{if } n = 1, \\ U(x,n) &= 0 && \text{if } n > 2. \end{aligned}$$

If the economy only has two people, then it is optimal to put them in a club of size 2. However, if the economy is replicated so that there are 4 people, then, surprisingly, it is not optimal to replicate the size-2 club. Instead, it is optimal to have one club of size 2 and two singleton clubs, with the private goods shared among the clubs and consumed efficiently. In fact, the maximum per-capita utility is achieved when the proportion of agents in groups of size 2 is $k^* = \frac{1}{1+\sqrt{2}}$. Only members of size-2 groups consume good 2 (since their marginal rate of substitution favors good 2), and only singletons consume good 1. The proportion k^* is chosen to ensure that there is exactly enough endowment of each type of good so that the agents can specialize in consumption while utility is equalized.

But this is the source of the existence problem. Even though the core is nonempty for every finite economy, competitive equilibrium does not exist except at the scale of the economy that maximizes per capita utility. [For the argument, see Gilles and Scotchmer (1997), where this example appears.] Since k^* is an irrational number, there is no finite economy that will permit a proportion k^* to be in groups of size 2, and hence competitive equilibrium does not exist for any finite economy. This shows that core/competitive equivalence fails for every finite economy.

To make the nonexistence of competitive equilibrium more concrete, suppose there are 10 agents. Per-capita utility is maximized with a proportion .4 people in groups of size 2 (2 groups). But .4 is slightly less than k^*, and utility must be equalized by letting the singletons consume some x_2 as well as x_1. The price ratio must be the marginal rate of substitution of singleton agents, namely, $\frac{p_1}{p_2} = \frac{\sqrt{2}}{1/2}$. Such an allocation cannot be a competitive equilibrium, since the agents in singleton clubs are spending more than the value of their endowment. ■

The fundamental premise of club theory, as described above, is that, if an allocation can be blocked, then it can be blocked by a group that is small [10]. Thus, all economic power is possessed by small groups. According to the above example, this idea is not preserved exactly when private goods are traded among members of different clubs. However, an approximate version of small-group effectiveness has long been known for private goods exchange economies, and could possibly be extended to general club economics. See Schmeidler (1972) and Grodal (1972) for continuum economies and Mas-Colell (1979) for large finite economies.

Following the intuition that club economies and exchange economies are not fundamentally different, Ellickson, Grodal, Scotchmer and Zame (2001) show a type of core/competitive equivalence for large finite club economies. Their interpretation is that large club economies are competitive because agents with the same characteristics are substitutes for each other in forming clubs, and since each agent belongs to a bounded number of clubs, no agent has more than a negligible impact on the economy. This is an application of Ostroy's (1980) requirement for perfect competition, namely, that no agent in the economy has more than a negligible impact on the utilities of others.

3. Free mobility equilibrium

The free-mobility notion is that there are no restrictions on migration, provided the migrant is willing to abide by the rules of the jurisdiction where he lives. Local services within jurisdictions are provided according to some pre-established rule, usually majority voting. Free mobility and voting outcomes are of interest because they seem to mimic social institutions, at least in Western democracies. However, they lead to inefficiencies and problems of existence. In this section I summarize some basic ideas about majority voting and redistribution in free-mobility models. Many of

[10] This idea lies at the heart of the papers on clubs in economies with single private goods, in particular, Buchanan (1965), Pauly (1970a,b), Stiglitz (1977), Wooders (1978, 1981, 1980), Boadway (1982), Berglas and Pines (1981), Scotchmer and Wooders (1987a,b) and Conley and Wooders (1997). It has been given many different names, for example, "optimal groups", "bounded groups", "efficient scale", and some that are defined for special cases like games with transferable utility [e.g., "effective small groups", Wooders (1992)].

the interesting applications concern parallel provision of services by public and private entities, which are discussed in Section 5 below.

Most models of free mobility equilibrium differ from the price-taking equilibrium of club economies in several important ways:

- There are implicit restrictions on side payments or “prices”, which are given by the cost-sharing rule within the jurisdiction, usually established by majority-voting.
- Immigration to a jurisdiction (and entitlement to its local public services) may require occupancy of land, which might be scarce. The rental price on land is then an implicit price of residency, along with taxes.
- Consumers can only belong to one jurisdiction.
- Instead of choosing within an abstract set of jurisdiction types, which might or might not exist, the agent is restricted to the jurisdictions that actually exist (or to no jurisdiction at all).

The importance of the last point was illustrated by applying the free-mobility idea to Buchanan clubs, where it led to groups of inefficient size. The inefficiency arises because free mobility does not allow coordinated deviations by many agents simultaneously.

In contrast to clubs, jurisdictions are typically defined geographically, so that their number is fixed. Limited geographic space is a natural source of crowding. In contrast to the club model, where crowding externalities occur because of direct interactions among agents, or because a larger membership increases the cost of providing the public good, crowding is caused in a geographic model by the scarcity of land, reflected in its equilibrium price. Regardless of how attractive the jurisdiction’s policies are, immigration can be limited by the high price of land.

The coupling of land consumption with the consumption of local public goods is the subject of Section 4. In the models there, agents are also freely mobile, assuming they are willing to pay the taxes imposed by jurisdictions. The focus is on efficiency. I ask what objectives the local jurisdiction should pursue, and how the local public goods should be funded, in order to ensure that local public goods are provided efficiently and residential choices are also efficient. In contrast, most concepts of free mobility equilibrium do not incorporate a local objective for a jurisdiction manager. Instead they assume that local decisions are made by majority vote.

In the papers on free mobility with majority voting, the policy space is generally collapsed to a single dimension, in order to avoid voting cycles. Example 5 follows that technique. Since taxes and expenditures are both modeled by a tax rate (they are linked by budget balance), it is hard to separate taxation for redistribution from taxation to fund local public goods. Income taxes have a redistributive aspect. However, the following example shows that both income taxes and local per-capita taxes will have distortionary effects on location choices.

Example 5. *Free mobility and redistribution*: Suppose that each of two jurisdictions, $i = 1, 2$, has an area equal to 1. Let the agents be indexed by their incomes $y \in [0, 1]$, where y is uniformly distributed on the interval. We shall refer to each jurisdiction as a subset of the agents, $J_1, J_2 \subset [0,1]$, where $J_1 \cup J_2 = [0,1]$. Each resident occupies space in amount $1/N_i$ in jurisdiction i, where N_i is the number of residents. We will assume that agents differ only by their endowment of income, and that their willingness to pay for public services increases with income (or private goods consumption). The utility function of an agent will be U, where $U^y(x,z,s) = x + b(z,y) + f(s)$. The variable x represents private goods consumption, z represents the level of public services, and s represents the land he consumes. Private goods endowment y is in the benefits function b to allow that the benefits for public services z can increase with private goods consumption, or incomes. (I use y instead of x to make the example simpler.)

Instead of using the utility function as given, we will write $y(1-t_i) + b(t_iY_i, y) + f(1/N_i)$ for the utility that an agent with income y receives in a jurisdiction with tax rate t_i, and total income $Y_i = \int_{J_i} y\,\mathrm{d}y$. Then t_iY_i represents the public services provided, which is equal to the revenue collected.

First we consider the voting outcome, conditional on residency choices. A type-y resident prefers the tax rate, say $t(y)$, that satisfies (assuming that b is concave in its first argument)

$$-y + b_1\,(t_iY_i, y)\;Y_i = 0, \tag{3}$$

or

$$y/\hat{y}_i - N_i b_1\,(t_iY_i, y) = 0, \tag{4}$$

where b_1 is the partial derivative with respect to the first argument, namely, the marginal willingness to pay for local public services, and $\hat{y}_i$ is mean income in jurisdiction i. If the marginal willingness to pay for public services $b_1(\cdot)$ does not change very much with income y, then the voter's preferred tax rate $t(y)$ will be decreasing with y. The fact that a high-income voter pays a disproportionate share of the cost will dominate the fact that he has higher willingness to pay for public services than low-income voters.

Whether the preferred tax rate is increasing or decreasing with income, the median voter's preferred level of public services could be close to efficient. Because of the uniform distribution of y in this example, the mean income and the median income coincide. If the marginal willingness to pay for public services increases with income at more or less a constant rate, then the average willingness to pay for a marginal increase in public services, $1/(N_i)\int_{y\in J_i} b_1(t_iY_i, y)\,\mathrm{d}y$, will be close to the willingness to pay of the median voter, $b_1(t_iY_i, \hat{y}_i)$. Thus, the Samuelson condition for efficient provision of public goods, which is $1 = \int_{y\in J_i} b_1(t_iY_i, y)\,\mathrm{d}y$, is "almost" satisfied by Equation (3), evaluated for the median voter, $\hat{y}$.

Interestingly, when taxes are the same for all residents, say τ_1, τ_2, rather than pro rata on income, t_1y, t_2y, the median voter will still choose public services close to the efficient level. In that case, the utility function for a resident of jurisdiction i is $-\tau_i + b(\tau_i N_i, y) + f(1/N_i)$. The residents' preferred tax rates satisfy

$$-1 + N_i b_1(\tau_i N_i, y) = 0. \tag{5}$$

The preferred tax rate, say $\tau(y)$, increases with income, provided that the cross-partial of b is positive. In this example, neither the income tax nor the per-capita tax substantially distorts the provision of public services, at least conditional on the allocation of residents to jurisdictions.

But although the two tax systems do not lead to substantial differences in the provision of local services, the two tax systems lead to opposite distortions in how the residents are divided. For purposes of showing this, I shall now assume that, under each tax system, the median voter implements the efficient level of public services in each jurisdiction, conditional on the division of agents between jurisdictions. We shall refer to these efficient expenditures on public services as $e(J_1)$ and $e(J_2)$.

For expository purposes, I shall focus on allocations in which the population is divided such that $J_1 = [0, \bar{y})$ and $J_2 = [\bar{y}, 1]$, so that agents with lower demand for public services are concentrated in jurisdiction 1, and agents with higher demand are concentrated in jurisdiction 2.

I first consider how a social planner would divide the population, and use the efficient division as a benchmark for evaluating the equilibrium. Since utility is quasilinear, the efficient partition would maximize total utility,

$$\int_0^{\bar{y}} (y + b(e(J_1), y) + f(1/N_1))\, \mathrm{d}y - e(J_1) + \int_{\bar{y}}^1 (y + b(e(J_2), y) + f(1/N_2))\, \mathrm{d}y - e(J_2).$$

Then the optimal expenditures $e(J_i)$, $i = 1, 2$, satisfy the Samuelson condition, $\int_{J_i} b_1(e(J_i), y)\, \mathrm{d}y = 1$. The optimal dividing point $\bar{y}$ will satisfy

$$\begin{aligned} &[b(e(J_1), \bar{y}) + f(1/N_1)] - [b(e(J_2), \bar{y}) + f(1/N_2)] \\ &\quad = \left[(1/N_1) f'(1/N_1)\right] - \left[(1/N_2) f'(1/N_2)\right]. \end{aligned} \tag{6}$$

Equation (6) can be interpreted to say that the direct benefits to the marginal person who moves from jurisdiction 1 to 2 must be balanced by the spatial congestion effects he generates. He liberates space in jurisdiction 1 and squeezes the other residents in jurisdiction 2.

Now consider the free mobility outcome. There could easily be multiple equilibria in how the population is divided, and, depending on details of the functions b and f, equilibrium might not exist at all. The prices of land in the two jurisdictions will be $f'(1/N_i)$, $i = 1, 2$, and the equilibrium lot sizes will be $1/N_i$. Accounting for expenditures on land, the marginal resident's utility in jurisdiction i is thus $\bar{y}(1 - t_i) - (1/N_i) f'(1/N_i) + b(e(J_i), \bar{y}) + f(1/N_i)$. In order that the marginal resident has no incentive to move, he should receive the same utility in both jurisdictions, accounting also for the difference in tax shares paid:

$$\begin{aligned}(t_2 - t_1)\, y + &\left[b\left(e\left(J_1\right), \bar{y}\right) + f\left(1/N_1\right) - \left(1/N_1\right) f'\left(1/N_1\right)\right] \\ &- \left[b\left(e\left(J_2\right), \bar{y}\right) + f\left(1/N_2\right) - \left(1/N_2\right) f'\left(1/N_2\right)\right] = 0.\end{aligned} \tag{7}$$

Conditions (6) and (7) are the same except for the first term in Equation (7), representing the difference in taxes.

Starting from an efficient allocation, as described by Equation (6), consider whether the marginal person has incentive to move. It is reasonable to think that the tax rate in the high-demand jurisdiction will be lower than in the low-demand jurisdiction, that is, $t_2 < t_1$. Of course, this depends on the income-elasticity of demand for public services, but even with $t_2 < t_1$, the public services could be substantially higher in jurisdiction 2 than in jurisdiction 1, due to the higher mean income. If $t_2 < t_1$, then at the optimal $\bar{y}$, the marginal resident has incentive to move from jurisdiction 1 to jurisdiction 2, essentially to avoid the subsidy that he implicitly makes to lower-income residents.

Now suppose that the taxes are per-capita rather than pro-rata on income. Replace $(t_2 - t_1)y$ with $(\tau_2 - \tau_1)$ in Equation (7). In this case, it is reasonable to assume that $\tau_2 > \tau_1$, at least if the jurisdictions have similar numbers of residents. This is because higher-income residents have higher demand for public services, and therefore the per-capita taxes will be higher. The marginal resident in jurisdiction 2 has relatively low demand for public services (because he has relatively low income), but pays the same fraction of cost as the higher-income residents. He has incentive to move to jurisdiction 1, which has lower public services, in order to escape the onerous taxation. He is avoiding a subsidy to higher-demand residents, whose preference for a high level of public goods determines the level of provision, and is partly subsidized lower-demand residents like himself. ■

The example suggests that, although voting creates certain distortions from the first best and may cause equilibrium not to exist, much of the distortion arises from the residency choices. The example shows two ways in which local taxes can be distortionary. Residents will locate to avoid paying a disproportionate share of the cost of public services when taxes are linked to income, and may relocate to avoid paying even an equal share, when the provision is greater than they prefer. Fernandez and Rogerson (1996) use such a model to study the effect of fragmentation and stratification on provision of schooling. Residents vote on linear income taxes, as above, and the taxes determine the quality of education provided. Two policy objectives – redistribution and provision of education – are governed by a one-dimensional policy variable. Jurisdictions with high average income vote for good schools. The free mobility equilibrium can be inefficient in the sense that moving some agents could increase the average income (hence the quality of education) in both jurisdictions. Fernandez and Rogerson discuss remedies to this problem, some of which mimic the solution in the clubs literature, namely, to price differentially (e.g., with subsidies) to reflect externalities.

In Example 5, the public services are a “pure public good” in the sense that the cost does not depend on the number of sharers. There is a crowding cost, but it arises entirely from the scarcity of land, which is separately priced. Therefore the arguments of Section 4.1 below apply: the form of taxation that does not distort location decisions is a land tax. With a land tax, there would be no tax term in Equation (7), and the residents' choices of location would coincide with the optimum. On the other hand, with a land tax, landowners instead of residents pay for the public services. Hence the residents might vote for an inefficiently high provision of public services, in order to transfer income from landowners to themselves. This observation highlights the importance of timing in the definition of equilibrium. The incentive to vote for high public services funded by land taxes would be damped if the residents predicted that such a policy would attract migration and push up the rental price of land, so that the benefits of high public services were capitalized. In most definitions of free mobility equilibrium, the voting public is assumed to be myopic in that it does not account for any migration that might be induced by a change in policies. Similarly, there is an issue of whether a migrant views the public services in his destination as fixed, or whether he predicts his own impact on the voting outcome.

Most of the literature on free mobility equilibrium has been focussed on existence. Equilibrium might not exist both because of majority voting and because of the instability that can be caused by a unilateral right to migrate. A good summary of various approaches to existence can be found in Konishi (1996), who presents a general existence theorem and summarizes the contributions of Ellickson (1971, 1973, 1977), Westhoff (1977), Rose-Ackerman (1979), Dunz (1989), Guesnerie and Oddou (1981), Greenberg (1983), Greenberg and Weber (1986), Greenberg and Shitovitz (1988), Epple, Filimon and Romer (1983, 1984, 1993), Epple and Romer (1991). See also Fernandez (1997), Fernandez and Rogerson (1995, 1996, 1998, 1999), Jehiel and Scotchmer (1993, 2001). Most of these papers do not involve crowding externalities within jurisdictions, aside from land. Crowding has been introduced by some of the more game theoretic papers; see Konishi, LeBreton and Weber (1998) and Conley and Konishi (2002). Some of these papers treat the pure voting problem, assuming that residents are not mobile. The definitions of equilibrium differ according to the timing of moves, and also in the cost structure of public services.

So far we have not considered direct externalities among residents. As in the clubs model, if agents cannot be taxed or subsidized to account for the externalities they create, then they will not account for the impact of their location decisions on the utility of other residents. This idea is particularly important when the direct externalities arise from peer effects, as with education. The implications have been explored, for example, by deBartolome (1990), Benabou (1993) and Epple and Romano (2002). Example 6 gives a flavor of how uncompensated direct externalities among residents can lead to inefficient location choices. In a more complicated model with endogenous labor skills and costly education, Benabou (1993, 1996a,b) shows that free mobility can not only reduce average welfare relative to the first best, but can do so without making any of the citizens better off. These papers emphasize how the distribution of population among jurisdictions affects the incentives to invest in labor skills, which again have a feedback effect on productivity and how the population is segregated (or not) in equilibrium.

The following example was suggested by work in progress of Nicolas Gravel and Alain Trannoy.

Example 6. *Free mobility with externalities among residents*: Suppose that agents are differentiated by their incomes $y \in [0, 1]$, and that each agent's utility of consuming private goods x and space s in a jurisdiction with mean income $\hat{y}$ is given by $x + \log(s) + \hat{y}$. That is, he receives a positive externality from being grouped with high-income agents. Suppose that there are two jurisdictions $i = 1, 2$, each with land area equal to 1. Every resident of each jurisdiction will occupy the same amount of space, $s_i = 1/N_i$, $i = 1, 2$. The price of land will be equal to the marginal utility of space, which is $1/s_i$, so that each agent's expenditure on land in each jurisdiction is 1. An agent's utility can therefore be re-expressed as depending on the number of residents in the jurisdiction he occupies, and the average income, i.e., as $y - 1 - \log(N_i) + \hat{y}$.

Consider equilibria that can be described by a partition into two jurisdictions $J_1 = [0, \bar{y})$, $J_2 = [\bar{y}, 1]$. Since utility is quasi-linear, an allocation that maximizes the sum of utilities is efficient, and thus the dividing point $\bar{y} = (1/2)$ is optimal. However, this will not be a free-mobility equilibrium. At that partition, the jurisdictions are the same size and have the same land prices, but have different mean incomes. The marginal agent will leave jurisdiction 1 for jurisdiction 2, which has higher mean income. By doing so, he lowers the average income in both jurisdictions, a negative externality that he does not account for in deciding to migrate. Since the average incomes in the two jurisdictions are, respectively, $\bar{y}/2$ and $(1/2) + \bar{y}/2$, and since $N_1 = \bar{y}$, $N_2 = 1 - \bar{y}$, the equilibrium $\bar{y}$ satisfies

$$\bar{y} - 1 - \log(\bar{y}) + \bar{y}/2 = \bar{y} - 1 - \log(1 - \bar{y}) + (1/2) + \bar{y}/2,$$

which implies that the equilibrium $\bar{y}$ is less than (1/2). The high-income jurisdiction is too large because agents will migrate there until land prices are high enough to discourage further immigration.

Another efficient partition is $J_1 = [0, 1/4) \cup [3/4, 1]$, $J_2 = [1/4, 3/4)$. This partition is a candidate for a free-mobility equilibrium [11], since, in contrast to the other efficient partition, all agents are indifferent between the two jurisdictions. But since the agents

[11] Whether this is a free mobility equilibrium depends on nuances of the definition. Suppose that a high-income agent contemplates migrating to jurisdiction 2. If the migrant accurately predicts that he will raise land prices and the average income in jurisdiction 2, and if, to overcome the artificiality of the continuum, a "small subset" is allowed to migrate, and if the increased average income adds more to his utility than the increase in land price subtracts, then this is not an equilibrium.

have no opportunity for coordinated action or side payments, they could get stuck in an equilibrium of the type previously described. ■

One of the messages in Section 2 is that externalities must be priced in order to ensure that an equilibrium (which will be efficient) exists. A message of Examples 5 and 6 is that free-mobility equilibrium might exist even without externality pricing, but will not typically be efficient.

The literature's attention to free mobility is presumably because it seems to be how Western economies operate, at least internally. However, this stylization is not entirely accurate. Many jurisdictions impose tests for admission, for example, a demonstration of potential to earn income. Remarkably little attention has been paid to the consequences of imposing such tests. A natural test for allowing a migrant to enter is majority consent, which would presumably capture the residents' fear that an immigrant would be a burden on the state. But the following example shows that, at least in one class of cases, majority consent is no more restrictive than an untested right to migrate.

Example 7. *Admission by majority vote*[12]: Suppose that in a free mobility equilibrium the jurisdictions are indexed $j = 1, \dots, J$, and the public services provided are $z^1, \dots, z^J$. The costs of public services are given by a function $c(z)$, shared equally by the residents, and the numbers of residents in the jurisdictions are $n^1, \dots, n^J$. Agents have willingness to pay parameters $\theta \in [\theta_o, \theta^o]$ and the utility of a type-θ person in jurisdiction j is $U^\theta(z^j, y - \frac{c(z^j)}{n^j})$. We assume that in each jurisdiction, the public services z^j are those preferred by the median θ in that jurisdiction. Suppose that a migrant shifts the median voter and changes the public services by $\mathrm{d}z^j$. (In a continuum model, the shift will be infinitesimal.) In addition, the size of the jurisdiction changes by $\mathrm{d}n^j$. The willingness to pay for this shift of a type-θ member is

$$\mathrm{d}U^\theta(\cdot) = \frac{\partial U^\theta(\cdot)}{\partial z^j}\mathrm{d}z^j + \frac{\partial U^\theta(\cdot)}{\partial n^j}\mathrm{d}n^j.$$

The first term is positive for half the members (the half with high θ if $\mathrm{d}z^j$ is positive), zero for the median voter, and negative for half the members. If this were the only effect, they would be evenly split on whether to admit the new member, whether his effect is to increase or decrease the public services. But the second term is positive, since every member's cost share decreases. Thus, at least half the members will approve the immigrant, whether $\mathrm{d}z^j$ is positive or negative, and the only test of equilibrium is whether anyone wants to migrate. The criterion of majority approval adds no restriction beyond free mobility. ■

[12] This example follows Jehiel and Scotchmer (2001).

4. Land, location and capitalization

In a certain sense, the club model can be interpreted as a model of endogenous jurisdiction formation in geographic space. Interpret one of the private goods as homogeneous land [13]. Agents sharing a particular jurisdiction (club) purchase land in addition to other private goods, and can be assumed to occupy contiguous lots, so the club could reasonably be interpreted as a "jurisdiction". The price of land in each of these endogenous jurisdictions is the same, which means that there are no capitalized differences among jurisdictions. This may seem curious, but it is a natural consequence of the hypothesis that land is fungible among jurisdictions. A piece of land can be annexed to a jurisdiction and removed from another, simply by transferring title from a member of one jurisdiction to a member of the other.

But, contrary to this re-interpretation of the club model, space is not fungible among jurisdictions. Instead of being decoupled as in the club model, the enjoyment of local public goods is coupled with consumption of land, of which there might be a fixed supply. This seems to be the essence of the local public goods problem.

The coupling of land with local public goods has three effects, which are explored in the following three subsections. First, it creates the possibility of capitalization. "Capitalization" means that the value of local public goods is captured in the price of the land to which the local public goods are attached. Second, the local public goods might be "located" in space, as museums and schools are, so that capitalization differs within jurisdictions as well as between jurisdictions. "Location" creates a problem of optimal siting. Third, consumption of land is bundled with consumption of local public goods, and because of this bundling, local public goods and also wage opportunities are "bundled" in the consumer's choice set.

Capitalization has been used in two ways to guide the efficient provision of public goods. First, capitalization effects have been used to estimate willingness to pay for public goods in cost-benefit analysis [see Rubinfeld (1987)]. Second, the theoretical literature has argued that an appropriate objective function for jurisdictions is to maximize the capitalized value of the land, as discussed below. A third way to use capitalization is suggested by Example 8. Namely, it could guide the efficient drawing of jurisdiction boundaries.

4.1. Diffused local public goods and capitalization

In this subsection I consider the economic environment most often discussed in the literature on local public goods with land, namely, that geographic space is pre-assembled into jurisdictions with exogenously given boundaries, and that the local

[13] The model of homogeneous land is itself limited, however. See Berliant and Dunz (1999) for the existence problems that can arise when agents care about the shape or other characteristics of their parcels.

public goods are "diffused", for example, quality of the road system, communications, and (perhaps) densely sited local schools. This is in contrast to the situation studied in the next subsection, where local public facilities are "located".

I focus on two important aspects of efficiency: agents' location choices must be efficient, and the public services within each jurisdiction must be efficient. The literature has addressed the following two questions about efficient allocations: (a) What price and tax systems are required to decentralize an allocation that is efficient in both senses, and (b) what should the objectives of local jurisdictions be, in order that in aggregate they will provide optimal local services, and agents will be allocated efficiently to jurisdictions? I consider these in the next two subsections.

4.1.1. How to pay for local public goods

In this subsection I do not consider how local public goods are chosen, but only how they are paid for, and how the taxes affect location decisions. An optimal scheme to pay for the local public goods is more complicated with geographic space than in the club model because there is a dual price system, consisting of both local taxes and land prices that arise anonymously in general equilibrium. The land prices play two allocative roles:

- Land prices allocate space within jurisdictions;
- Land prices capitalize the value of local externalities and public services, and thus affect residency choices.

Given that land prices play dual roles, it is perhaps surprising that, if the cost of local public services does not depend on the number of residents, and if there are no direct externalities among agents (as in Example 9 below), an efficient allocation should be financed entirely from land taxes. Otherwise residents will not locate efficiently.

Many arguments have been given in defense of this idea, mostly in models with homogeneous agents, e.g., Wildasin (1980) (who also assumes quasilinear utility) and Hochman (1981). See also the survey by Mieszkowski and Zodrow (1989). The intuition is basically that land in each jurisdiction is a private good, and private goods will be allocated efficiently by the market (conditional on the local public goods and fixed boundaries). If we think of the agents as bidding for places in jurisdictions, then the places will be allocated to the highest bidders, as would be efficient. The bid process capitalizes the public services into the land prices in different jurisdictions. If the price is high, agents will want to economize on lot size, which makes room for more residents, as is also efficient. This is how the dual roles of the land prices fit together. (See Fujita (1989) or Scotchmer (1994) for more formal discussions of these two roles.) There is no mention of taxes in this argument. Taxes that would distort the consumers' choices would obstruct the efficient functioning of the land market. And of course the argument assumes that the local public goods have been chosen efficiently in advance, and that the cost does not change when residents change jurisdictions.

In contrast to land taxes, income or local sales taxes affect residency choices. The thrust of the literature, illustrated in Example 8 below, is that such taxes should only be used to fund the local public goods if agents impose externalities on each other. Such externalities could be direct, as when a cat owner moves into a neighborhood of bird watchers, or it could be indirect, such as when the resident has many school-age children who increase the cost of local schools. Example 8 shows that, when there are externalities, land taxes must be supplemented by jurisdiction-specific taxes that internalize marginal costs imposed by the resident. Without such taxes, agents will not be allocated efficiently among jurisdictions.

The examples below show the following points about decentralizing an optimum when jurisdiction boundaries and local public goods are fixed in advance. There is a rich literature from which these principles derive, including Starrett (1980), Pogodzinski and Sjoquist (1993), Strazheim (1987), and Brueckner (1979).

- If the cost of local public goods depends on the number or characteristics or residents, then the local public services in an efficient allocation should not be financed with land taxes alone. Taxes with allocative effects are also necessary.
- Land prices can capitalize differences in local public goods, but consumers could be better off if land could be transferred among jurisdictions so that capitalization vanished.
- If residents' utility depends on the external characteristics of other residents, such as noisiness, criminal propensities or education, then an equilibrium may not exist without imposing different taxes on residents with different external characteristics. And such prices are required for efficiency.

Example 8. *Dual price system*: Suppose that there is a per-resident cost of 1 for providing crime control. There is a continuum of agents with willingnesses to pay θ, uniformly distributed on $[0, 2]$. Consumers have preference $\theta z + x + \log s$ where $z \in \{0, 1\}$ is the level of crime control, x is private good consumption and s is the amount of space occupied. There are two jurisdictions with sizes $A_2 = A_1 = 1$. Suppose for simplicity that there are absentee landlords[14], and that crime control is financed by land taxes which have no affect on the allocation of space or residency. Then the following is an equilibrium: jurisdiction 2 provides crime control, but not jurisdiction 1. Land prices are related to lot sizes by $p_i = 1/s_i$, $i = 1, 2$. Agents $\theta \in [\bar{\theta}, 2]$ reside in jurisdiction 2 (there are $(2 - \bar{\theta})/2$ such agents), and agents $\theta \in [0, \bar{\theta}]$ reside in jurisdiction 1 (there are $\bar{\theta}/2$ such agents), where $\bar{\theta}$ satisfies

$$-\log\left[\left(2 - \bar{\theta}\right)/2\right] + \bar{\theta} = \log s_2 + \bar{\theta} = \log s_1 = -\log\left[\bar{\theta}/2\right].$$

Hence $0 < \bar{\theta} < 1$.

[14] A land owner cannot escape land taxes by changing his residency, since the land is still taxed. This is why it has no allocative effect. Further, there is no reason to think that each person owns land in the jurisdiction he occupies. Residency choices can be decoupled from land ownership. Thus, the incentive effects of different kinds of taxes can be understood in the simplest kind of model where everyone is a renter.

However this is not efficient. In an efficient allocation, half the agents, $\theta \in [0, 1]$, are in jurisdiction 1 with no crime control, and the other half, $\theta \in (1, 2]$, are in jurisdiction 2 with crime control. All agents consume the same amount of space. In the equilibrium there are too many agents in jurisdiction 2 with crime control because they are not required to pay the marginal cost of providing it. This shows that the efficient allocation cannot be supported only with land taxes. The inefficiency could be corrected by imposing a head tax in jurisdiction 2, equal to the marginal cost of providing the local public good to an additional person.

In this example with linear costs, the revenues from the optimal head tax cover the whole cost of the local public goods. If there were fixed costs as well as marginal costs, the head tax would have to be supplemented with a tax on land. ■

Krelove (1993) and Wilson (1997) recognize the importance of internalizing cost externalities, and argue that if direct taxes on residents are not allowed, then property taxes (including taxes on structures) are superior to land taxes as an approximation. Nechyba (1997a) considers the possibility of income taxation as well as property taxation, and argues that jurisdictions will always opt for property taxes, since they can make their communities relatively more attractive by switching from income to property taxes. Income taxes, to the extent they are used, are imposed by higher levels of government. Nechyba (1997b) shows existence of an equilibrium in which local public goods are financed through property taxes and national public goods are financed by income taxes. Both are established by the vote of residents, rather than by an objective function such as land value or profit. He does not address the efficiency of such an equilibrium.

I now continue Example 8 to show that the nonfungibility of land creates the capitalization effect, and imposes a social cost on the economy as a whole, by creating an artificial scarcity of the produced local public goods. (I distinguish natural local amenities, such as views and climate, from produced local public goods. Both can be capitalized into the price of land, but the natural amenities cannot be changed, and the capitalization effect cannot be avoided.)

Example 8 (continued). *Capitalization and the nonfungibility of land*: We showed that, since residents impose marginal costs on the provision of the local public good, the cost should be at least partially covered by taxes with allocative effects such as head taxes. Assume then that residents pay the marginal cost 1 so that their net willingness to pay for crime control is $\psi = (\theta - 1) \in [-1, 1]$. Suppose that in an optimum all agents $\psi > \hat{\psi}$ occupy jurisdiction 2, where $\hat{\psi}$ satisfies

$$\hat{\psi} + \log s_2 = \hat{\psi} + \log \left[A_2/(1 - \hat{\psi})\right] = \log \left[A_1/(\hat{\psi} + 1)\right] = \log s_1.$$

If $A_2 < A_1$, this implies that $\hat{\psi} > 0$ and $p_1 < p_2$. That is, the differential value of crime control is capitalized into the land price in jurisdiction 2 when agents are partitioned optimally. Agents in jurisdiction 1 with positive net willingness to pay are deterred from moving to jurisdiction 2 by the high price of land. They would like to annex their land to jurisdiction 2. If this were possible, the price of land would end up equal in both jurisdictions, and the population would be better served, since all agents with $\psi > 0$ would receive crime control. The fact that the geographic space has been divided in advance creates an artificial scarcity of crime control, and creates a capitalization effect. ■

The next example illustrates the principle, suggested by the club arguments above, that when there are direct externalities among the agents, an allocation must be supported by taxes that include transfers among agents with different external characteristics.

Example 9. *Internalizing externalities*: Suppose there are two types of external characteristics, B and G. For simplicity, assume that agents of each type have the same preferences, and that each agent is endowed with 1 unit of a private good. There is a continuum of each type with measure 1. Let b represent the ratio of type-B agents to type-G agents in a jurisdiction.

Suppose there are no local public goods except externalities among agents. Externalities are experienced only by the type-G agents, who have utility function $(b + \log s + x)$, where s is land consumption and x is private good consumption. Type-B agents have utility function $(\log s + x)$. There are two jurisdictions. It is optimal for one jurisdiction, say jurisdiction 1, to include all the type-G agents and a fraction, say n_B, of type-B agents, and for jurisdiction 2 to include only the remaining $1 - n_B$ type-B agents. For efficiency in the allocation of space, all agents in the same jurisdiction will occupy the same amount of space, s_1 or s_2, but $s_1 < s_2$. The total space in each jurisdiction is 1. The prices of land are $p_i = (1/s_i)$, $i = 1, 2$, so $p_1 > p_2$.

To support this allocation as an equilibrium, type-B agents must be indifferent between the two jurisdictions. They must be "bribed" to live in jurisdiction 1, which has a higher price for land. The bribe can be accomplished with a transfer tax from the type-G agents to the type-B agents living in jurisdiction 1. Since type-B agents confer positive externalities on type-G agents, type-G agents must compensate them for their presence. It would not suffice for the agents to pay different prices for land instead of head taxes, as that would distort the allocation of space. If public goods were provided, then the transfer tax could take the form of assigning a smaller share to type-B. ■

4.1.2. The local objective function

The previous subsection investigated how the local services should be financed, recognizing that taxes can affect agents' location decisions as well as paying for the local public goods. We now ask the broader question of whether local jurisdictions have incentive to provide local services efficiently, and whether they have incentive to use the tax systems that result in optimal location decisions. Two key questions are:

(1) what is the jurisdiction manager's objective function, and (2) does he wield tax instruments consistent with the prescriptions in the previous subsection?[15]

An old hypothesis is that if jurisdiction managers act on behalf of land owners, they will achieve an allocation that is efficient both in its public goods provisions, and in the allocation of residents to jurisdictions. Pines (1991) refers to this hypothesis as "Tiebout without Politics", and I shall refer to it as the "capitalization hypothesis". Its roots go back at least as far as Hamilton (1975) and Sonstelie and Portney (1978), with ongoing discussion by Wildasin (1979, 1987), Wildasin and Wilson (1991), Epple and Zelenitz (1981), Brueckner (1979, 1983), Henderson (1985), Starrett (1981), Pines (1985) and Scotchmer (1994) (giving an argument where residents have different tastes). By the argument given above, residency choices will be efficient as a consequence of individuals' optimizing choices and endogenous land prices, provided the right tax instruments are used to fund the local public goods. The intuitive argument for efficient provision of the public services is even more straightforward: The way to maximize land values is to cater to residents' preferences, so that they bid up the price of land. If the cost of public services is covered by land taxes, then maximizing land value is like maximizing the residents' aggregate willingness to pay for public goods, net of costs.

However, there are at least two unresolved issues related to the capitalization hypothesis. First, jurisdictions can overlap in geographic space, which means that the local public goods provided at each location are provided by different jurisdictions. An agent cannot unbundle these local public goods in choosing his residency. To my knowledge, the capitalization hypothesis has not been extended to accommodate overlapping jurisdictions. Suppose, for example, that a county-level government has responsibility to provide public transportation, and the cities have responsibility to provide roads. Suppose that both levels of government are motivated to choose the policies that maximize land values. Can they nevertheless get stuck in an inefficient equilibrium where, for example, counties fail to provide bus service because the roads are inadequate, and cities fail to improve the roads because they are not needed for bus service?

Second, when a jurisdiction manager contemplates an improvement to local services, how does he predict the consequences for land value? Such a prediction is an essential part of the theory. Depending on agents to "vote with their feet", as suggested by Tiebout, will not lead to efficiency in public goods provision unless managers are proactive in choosing the public goods that will attract residents. If, for example, all jurisdictions in the economy have a common level of services, e.g., bad schools, there is no reason for agents to choose any jurisdiction over any other. There will be no

[15] I assume here that the only possible policy instruments are the level of local public services and the tax instruments. Some authors have assumed that the jurisdiction manager can choose the residents directly. I find this assumption unsatisfying, as there could be a conflict between the desires of the manager and the optimal choices of prospective residents. Another policy instrument is zoning; see Wheaton (1993).

variation in land prices, and no evidence from the cross-section that an improvement would lead to a net-of-tax increase in property value or an increase in aggregate consumer welfare.

In fact, the cross section may be an inadequate guide to predicting capitalization even if there is variation in local public services. Whatever the local provisions of public services are, agents will sort themselves to jurisdictions efficiently. Those with relatively high demand for, say, good schools will reside in jurisdictions with good schools. The land price in a jurisdiction with good schools will reflect the valuations of the people who live there, but not of the people who live elsewhere. Because of this sorting, a jurisdiction that improves its public services so that it is similar to another jurisdiction will not typically end up with the same land prices; in fact, if the number of jurisdictions is finite, land prices in both jurisdictions could fall.

Despite its longevity, the capitalization hypothesis has only been proved in very simple models. Apparently this is due to difficulties in formulating how the jurisdiction manager would evaluate the capitalization effects of a local change. The technique most closely tied to competitive theory would be to hypothesize a price system that is independent of the local manager's policies [16]. As suggested by Example 9, the price system must be dual. It must include the externality taxes required to support an efficient allocation of residents to jurisdictions. And of course it must include land prices to measure the capitalization effect. The land prices would capitalize the taxes as well as the local services in each jurisdiction. As I have mentioned, such a price system could not reliably be found by observing the cross section.

Arguments for the capitalization hypothesis have relied on notions of "perfect competition", most often formulated as "utility-taking". Utility-taking means that the policies of any single jurisdiction do not affect the utility opportunities of residents or potential residents elsewhere. That is why the capitalized value of a change in the local policy will reflect the residents' willingness to pay. If the competitive hypothesis is reformulated as price-taking, as suggested above, then the notion would be that the prices for every type of local jurisdiction would be immune to any change in a single jurisdiction's policy, and that is why utility opportunities elsewhere do not depend on the local policy.

The competitive hypothesis does not hold if each jurisdiction is "large" relative to the rest of the world. The benefits of an improvement in local public services can be exported via pecuniary externalities. For example, if an improvement in local public services will induce immigration, reducing the price of land in other jurisdictions, it makes the residents who remain in the other jurisdictions better off [Scotchmer (1986)]. Capitalization in the improved jurisdiction is thus damped, and underestimates the value of the improved services.

Two alternatives to maximizing land values are majority voting, discussed above, and maximization of residents' welfare. A problem with welfare maximization is how

[16] Scotchmer (1994) uses this technique, but not in a model with crowding externalities.

to deal with migration. Migration must be allowed, since residency choices are an important aspect of allocative efficiency. But with migration, whose welfare counts to a jurisdiction manager? Does he take account of the immigrants or emigrants? Boadway (1982) postulated a welfare function that takes account of residents' and nonresidents' utility together, but in a model with one type of agent, so that any increase in local utility is exported equally to residents of other jurisdictions. Maximizing the welfare of all agents, both residents and nonresidents, seems difficult when agents differ, and when they sort themselves according to the jurisdictions they prefer. In addition, an objective function in which each jurisdiction takes account of the welfare of the whole economy seems to contradict the notion of "decentralization".

An issue that has received considerable attention in the literature is "tax-exporting". Can jurisdictions create value for their residents by taxing nonresidents? This idea was explored by Arnott and Grieson (1981), who argued that jurisdictions have an incentive to pay for their local public goods by taxing commodities that are consumed by nonresidents, or possibly by taxing land and housing that are owned by nonresidents. Similar ideas have been discussed more recently by Crane (1990) and Kim (1998).

However, the attempt to export taxes to nonresidents can be foiled by capitalization. Suppose, for example, that landowners are nonresidents, and a jurisdiction imposes a tax of T per parcel, which it then rebates to residents. This looks on the surface like a transfer from nonresidents to residents, but the transfer is at least partly foiled by capitalization. Rental values in the jurisdiction (hence the capitalized value of land) will increase. In fact, if the number of lots in the jurisdiction is fixed, then the rental price increases by T, so that both residents and landowners end up in their initial positions. There are nuances to this line of reasoning, but the basic insight is that capitalization makes it difficult to create benefits for residents at the expense of landowners. Conversely, it is difficult to create benefits for landowners except by creating benefits for residents. This observation lies at the heart of why maximizing land values leads to efficiency, regardless of whether residents are renters or owners.

On the other hand, taxing the *structures* on land is similar to taxing externally owned capital. With a local tax on capital, less housing capital will flow to the jurisdiction, which hurts residents even if their local public services are partly covered by capital owners who live elsewhere. For a more complete discussion of the relationship between capital taxation and property taxation, see Mieszkowski and Zodrow (1989).

The local incentive to export taxes is closely tied to issues of "fiscal federalism", the label under which authors have asked how the authority to tax and spend should be divided among hierarchical governments. For an integrative survey, see Oates (1999). Inman and Rubinfeld (1996), following Gordon (1983) and Arnott and Grieson (1981), argued that tax exporting should be prevented, since it has distortionary effects. It can be prevented by paying for local public goods with federal taxation rather than local taxation. However subsidies from the federal government to local governments also lead to perverse incentives, mostly centered on asymmetries of information.

4.2. Location

The model of the previous section has "land without location". The public goods are diffused throughout the jurisdiction, and residency within the jurisdiction entitles (or obligates) the resident to enjoy them. Such goods might be the transportation system, communications system or crime control. However, local public goods such as schools and museums are "located" within the jurisdiction. Strident politics surround their siting, and land values within the jurisdiction depend on where they are. Users must pay a transportation cost to enjoy them, in addition to any user fees. This leads to several additional questions: what rules should be obeyed in siting facilities optimally? Do local jurisdictions have incentive to obey those rules? How does "location" affect the optimal mix of taxes?

Location is the aspect of local public goods that has probably been discussed least. It is discussed under the name "spatial clubs" by Starrett (1988), and under the name "neighborhood goods" by Fujita (1989). See also Arnott and Stiglitz (1979), Thisse and Wildasin (1992), Thisse and Zoller (1982), Hochman (1981, 1982a,b, 1990) and Hochman, Pines and Thisse (1995). Location blurs the line between private and public goods. The theory of spatial clubs is very close to the theory of firm location, and inherits all the difficulties that arise there. A Hotelling firm sells to all the customers who are willing to bear the transportation cost, and because of its local monopoly, can make profit even if it has high fixed costs and zero marginal costs. If a spatial club has only a fixed cost and no marginal congestion costs due to the number of users, then it is precisely a Hotelling firm selling a private good. The same location theory applies, provided the spatial clubs are provided by profit-maximizing firms rather than by public institutions. The main conclusions of the Hotelling-based theory concern the fact that an equilibrium might not exist, and if it does exist, might be inefficient in both the locations of firms and their pricing policies. See Anderson, DePalma and Thisse (1992, Chapter 8), for a summary of these theories.

However, location theory as it has been applied to public facilities has a different focus than location theory as it has been applied to firms. Instead of focussing on the existence and properties of a noncooperative equilibrium, the focus has been on the social planning problem of where facilities *should* be located, and how their costs *should* be covered. In ordinary nonspatial clubs of the Buchanan type, the optimal size of a club balances congestion costs against the benefits of sharing the costs of a facility. An efficient size has the property that the marginal congestion cost imposed by the marginal member is just equal to the cost of the facility averaged over members. However, Example 10, which follows an idea of Hochman, Pines and Thisse (1995), shows how this conclusion must be modified if clubs are located in space. They conclude that

- Unlike nonspatial clubs, the cost of spatial clubs should not typically be covered entirely from user fees. Spatial clubs should also be subsidized from land rent.
- Each jurisdiction should contain many facilities of each type (schools, hospitals), each serving an optimal area. Since optimal areas differ for different types of facilities, such a jurisdiction might have to be very large.

- Given that jurisdictions have the right size, land-value maximization should lead to the right mix of land-rent subsidies and user fees, as in the previous section.

Example 10. *Spatial clubs*: Let every agent's utility be represented by $U(\upsilon) + x$ where υ is the number of visits, x is the private good consumed, and U is concave. Let the cost of the facility be given by $C(V)$ where V is the total number of visits to the facility. Assume that C is U-shaped. If the facility were provided optimally in a nonspatial context, the optimal number of visits and members, (υ^*, n^*) would satisfy $U'(\upsilon^*) = \frac{C(n^*\upsilon^*)}{\upsilon^* n^*} = C'(n^*\upsilon^*)$. Thus, the optimum would be supported if each agent pays a price per visit equal to the marginal cost $C'(n^*\upsilon^*)$, and the club is self-supporting [17].

However, when the club is located in space, each visit requires a transportation cost. Suppose that residents have measure one on each unit of an infinite line. Then it is optimal to locate spatial clubs at equal distances, and for residents to travel to the closest facility. The number of residents traveling to each facility is equal to the distance between facilities, but residents will visit with different frequency, depending on their personal distances to a facility. Let $\upsilon(t;\, T)$ represent the frequency of visits by agents who live at distance t from the closest facility when the distance between facilities is T (so that the "market area" of each facility extends a distance $T/2$ on each side). Assume that the cost of travel is \$1 per unit distance per visit.

I will solve the optimal siting problem in two parts. The optimal visit function $\upsilon(\cdot;\, T)$ maximizes

$$2\int_0^{T/2} [U(\upsilon(t;\, T)) - t\upsilon(t;\, T)]\, \mathrm{d}t - C\left(2\int_0^{T/2} \upsilon(t;\, T)\, \mathrm{d}t\right),$$

and satisfies

$$U'(\upsilon(t;\, T)) = t + C'\left(2\int_0^{T/2} \upsilon(t;\, T)\, \mathrm{d}t\right), \quad t \in \left[0, \frac{T}{2}\right]. \tag{8}$$

That is, the marginal utility of a visit from each distance t must equal the travel cost plus the marginal resource cost of the visit. Once the facilities are located, optimal visit rates can be guaranteed by charging a price per visit that is equal to the marginal cost $C'(\cdot)$, as one would expect.

However, since the marginal cost depends on total usage, and since total usage depends on how the facilities are spaced, the question of whether the revenue from optimal visit prices will cover the total cost of the facility is connected to the optimal spacing of the facilities. Letting $\upsilon(\cdot;\, T)$ be the solution satisfying Equation (8), and

[17] To see how equilibrium theories described above relate to this version of the club problem, see Scotchmer (1985b) and Scotchmer and Wooders (1987a).

letting $V(T) = 2\int_0^{T/2} \upsilon(t;\, T)\,\mathrm{d}t$ (the total number of visits to a facility when they are spaced at distance T), the optimal distance T maximizes per-capita utility:

$$\frac{1}{T}\left[2\int_0^{T/2}\left[U(\upsilon(t;T)) - t\upsilon(t;T)\right]\,\mathrm{d}t - C(V(T))\right].$$

The optimum T satisfies

$$\begin{aligned}
&U\left(\upsilon\left(\tfrac{1}{2}T;T\right)\right) - \tfrac{1}{2}T\upsilon\left(\tfrac{1}{2}T;T\right) - \upsilon\left(\tfrac{1}{2}T;T\right)\,C'(V(T))\\
&\quad= \frac{1}{T}\left[2\int_0^{T/2}\left[U(\upsilon(t;T) - t\upsilon(t;T)\right]\,\mathrm{d}t - C(V(T))\right]\\
&\quad= \frac{1}{T}\left[V(T)\,C'(V(T)) - C(V(T))\right]\\
&\quad+ \frac{1}{T/2}\int_0^{T/2}\left[U(\upsilon(t;T) - t\upsilon(t;T) - C'(V(T))\,\upsilon(t;T)\right]\,\mathrm{d}t.
\end{aligned} \tag{9}$$

Using Equation (8) and the concavity of U, and the fact that $\upsilon(\cdot, T)$ is decreasing, the integrand of the last term of Equation (9) is decreasing with t. Hence

$$\begin{aligned}
&U\left(\upsilon\left(\tfrac{1}{2}T;\,T\right)\right) - \tfrac{1}{2}T\upsilon\left(\tfrac{1}{2}T;\,T\right) - \upsilon\left(\tfrac{1}{2}T;\,T\right)\,C'(V(T))\\
&\quad< \frac{1}{T/2}\int_0^{T/2}\left[U(\upsilon(t;T) - t\upsilon(t;T) - C'(V(T))\,\upsilon(t;T)\right]\,\mathrm{d}t.
\end{aligned} \tag{10}$$

Together with Equation (9), (10) implies that $[V(T)\,C'(V(T)) - C(V(T))] < 0$. Thus, if each visitor is charged the optimal visit price equal to $C'(V(T))$, the costs will exceed the revenue. The deficit can be made up by taxing property.

The intuitive reason that revenues fall short is that spatial clubs should optimally be more plentiful (have smaller membership) than nonspatial clubs, since transportation costs can be reduced by having more clubs. Each club operates on the downward sloping part of its U-shaped average cost curve, which implies that marginal cost pricing will not be sufficient to cover costs.

If there are many different types of facility, then the jurisdiction must be of an appropriate size to accommodate integer numbers of optimal "market areas", say $T_1^*, \ldots, T_m^*$. It follows that the jurisdiction might have to be very large.

Further, the example has implications for fiscal federalism. Since many different types of clubs will typically have to be subsidized out of the same land value, presumably under a single taxing authority, that same authority should have competency for providing all the public facilities. ■

4.3. Bundling

The club model in Section 2 decouples geography from group formation. In my view, the decoupling is what distinguishes clubs from local public goods. When local public goods and other externalities are tied to a geographic location through the consumption of land and housing, then the consumer faces choices among *bundles* of local public goods, and the local public goods are also bundled with production opportunities and land. Each jurisdiction represents a different bundle, and to gain access, the resident must pay for some land.

Perhaps the most underexplored consequence is that many local services are bundled with occupancy of a single plot of land. They are provided by different jurisdictions, including, in the USA, the city, the county, special assessment districts, and the state. There is potentially a problem of coordination, as suggested by the bus and road example above.

The bundling of labor opportunities and provision of local public goods was first explored by Berglas (1976b), who considered the conflict between forming heterogeneous groups in order to exploit their complementarities in production, and forming homogeneous groups in order to exploit their shared tastes for public goods. Notice that if the agents could join "firms" that are different than "consumption communities", then no conflict would arise. They would join different groups for different purposes, as in Ellickson, Grodal, Scotchmer and Zame (1999a,b, 2001).

Bundling of production and local public goods is further explored by Wilson (1986), McGuire (1991) and Brueckner (1994). While Berglas, Brueckner and McGuire focus on production functions with two types of labor, Wilson focuses on a production function with labor and land. He shows that if there are two private goods – one with a labor-intensive production function and another with a land-intensive production function – then the communities should specialize so that workers can mostly live in a community using the labor-intensive production technology, and reaping the benefits of high public services, which are provided to them cheaply due to economies of scale. Even though people are alike, communities should be asymmetric. Asymmetry is the consequence of bundling in all these models.

Much of the focus in these investigations is on whether groups should be "homogeneous" or "heterogeneous". In my view, this is not an instructive question, since, typically, no two agents will be alike, and it is not obvious how to stylize their similarities. It is almost tautological that agents with the same tastes who face the same prices will make the same choices. But if they differ in productive skills or other external characteristics, they will not necessarily face the same prices. A competitive economy should get the grouping right under the right kind of pricing scheme, irrespective of what the optimal grouping happens to be. We should not need to know in advance whether the efficiencies from exploiting complementarities in production outweigh the inefficiencies from grouping people with different tastes for public goods.

5. The public–private interface

It is not obvious what we should mean by "public" and "private" provision of local public goods. The most natural distinction is probably one of objectives. In the clubs model of Section 2, clubs are supplied in response to the profit motive. The geographic model in Section 4 was originally motivated as a model of profit-maximizing land developers, who would furnish their land with infrastructure and services only to the extent that it increased the value of the land. It was a later realization that managers of public jurisdictions could adopt the same objective function as land developers. These are profit objectives, and they lead to efficiency. If local jurisdiction managers choose some other objective, it is presumably because they have values other than efficiency. The profit motive can even cause decision makers to internalize crowding externalities, provided that all such externalities occur within the club or jurisdiction.

I have mentioned two other objectives that public decision makers might plausibly follow, namely, the objective of maximizing local residents' welfare, and the rule of deciding local public goods by majority vote. As I have noted, the objective of maximizing welfare is not easily implemented when changes in local policy lead to migration. In fact, most authors studying the parallel provision of services by public and private entities have assumed that the public provision is decided by majority vote, where the voters do not account for the effect of their policies on migration.

Other differences between public and private providers might arise because public authorities are legally bound not to exclude users, or legally bound not to price differently according to externalities. And, most importantly, they might have a mandate to tax progressively, rather than according to the tax instruments discussed above that support efficient allocations. Thus, many authors assume that the tax instrument must be an income tax.

It should be apparent that the right to migrate can obstruct redistributive policies. There is a body of scholarship, mostly not reviewed in this paper, that focuses precisely on how migration undermines redistribution. See Epple and Romer (1991) and Epple and Platt (1998). Example 5 shows that if agents are paying too much for public services that they do not value, they will decamp to a jurisdiction with fewer services. Policies with a redistributive aspect may cause high-income citizens to go somewhere with lower taxes, or to a location where they will be subsidized instead of subsidizing, thus undermining the attempt to redistribute.

However, in many instances it is difficult or impossible to escape taxation by forming a new jurisdiction or migrating, e.g., when the tax is imposed by the highest level of a federal system. But even if agents cannot escape taxation, they can form private "quasi-governments" in parallel [Helsley and Strange (1991, 1998, 2000a)]. A parallel quasi-government formed by a select group of citizens can have two effects, both of which could benefit the members, but have ambiguous effects on nonmembers. First, the quasi-government can supplement the public services in accordance with the members' preferences. Second, depending on the cost structure, their private provision might crowd out the public supply, thus reducing the subsidy they must make to nonmembers.

The following example, adapted from Helsley and Strange (1998), investigates crowding-out.

Example 11. *Private supplements to public services*: Suppose that the willingness to pay for quality of service is θ, and that θ is uniformly distributed on a domain $[0, 1]$. Let g represent the quality of service, and suppose that preferences are $\theta f(g) - t$, where f is concave and t is the tax paid.

We will consider two cases, first that the cost of providing service is linear on the number of persons served, but depends on quality, and then that the cost of local services has the "pure public goods" feature that the cost is independent of the number of residents.

Suppose first that the cost is cg per person served, and that residents share the costs equally, so each resident's tax is cg. Then preferences are given by $\theta f(g) - cg$. Let $G(\theta)$ represent the preferred quality of type-θ, namely the value which satisfies $\theta f'(G(\theta)) = c$, and notice that the preferred quality increases with θ. For any group say $\Theta \subset [0, 1]$ let $E(\theta \mid \Theta)$ represent the mean value of θ in the group. Then $G(E(\theta \mid \Theta))$ is the level of public service that maximizes the group's total utility, $f(g) \int_{\Theta} (\theta - cg)\, \mathrm{d}H(\theta)$.

The best quality for the group as a whole is $G(E(\theta \mid [0, 1])$. This is a smaller level of public service than any subset of high-demand residents, $\Theta = [\bar{\theta}, 1]$, would prefer. Suppose that such a group decides to provide a supplement to its members, e.g., by funding after-school activities. The total level of public service in the splinter group will be $g + \gamma$, representing the services provided by the two sectors respectively. Whatever the service g provided by the public sector, the splinter group will choose γ to satisfy $\gamma = G(E(\theta \mid \Theta)) - g$. That is, it will make up any difference between the public's provision and its preferred level of public service. It follows that the level of public service enjoyed by the splinter group will be higher than if they did not form a parallel quasi-government. As long as there are no fixed costs associated with formation, they will also be better off than if they did not form the group.

The rest of the population will receive less public service than otherwise. Knowing that γ will be chosen to satisfy $f'(g + \gamma) E(\theta \mid \Theta) = c$, the public sector will provide $G(E(\theta \mid \sim \Theta))$, where $\sim \Theta$ represents the nonmembers of the splinter group. Thus, the nonmembers will receive less service than if the splinter group did not form.

So far this sounds like an unambiguously good arrangement, since both groups end up with a provision of services closer to their optima. However, Helsley and Strange show that, when there are fixed costs associated with forming the parallel quasi-government, the splinter group might be better off if they could commit in advance not to supplement the public offering. There is a kind of strategic downloading: the public sector provides a low level of service, leading high-demand agents to incur the fixed costs of forming a splinter group to supplement the services. But even though forming a splinter group is a best response to a low public offering, the members would be better off with the higher offering that the public administrator would make if no splinter group was allowed to supplement.

Now modify the example so that the public services have the cost structure of "pure public goods", namely, that the cost depends only on the quality of service provided, namely the total cost is cg. The cost does not increase with the number of residents sharing the public good. (Above, the total cost was cg times the number of residents.) Suppose that a splinter group of high-demand residents, $[\bar{\theta}, 1]$, forms in order to supplement the public goods. The total public goods will be $g + \gamma$, where γ is the supplement. Since the splinter group receives the publicly provided goods g as well as the supplement γ, their decision rule is to increase γ until $f'(g + \gamma)(1 - \bar{\theta}) = c$. The public authority's objective is to provide the public goods g efficiently to the whole population, so their decision rule is $\bar{\theta} f'(g) + (1 - \bar{\theta}) f(g + \gamma) = c$. If $g > 0$ and $\gamma > 0$, these two decision rules are inconsistent. The timing of moves would matter in defining an equilibrium, but it is reasonable to conclude that there is no real advantage to forming a splinter group, since, if the public authority obeys its own objective, the splinter group would not want to supplement the public goods. ■

This example suggests that if the cost structure of public services is more like private goods than public goods, then splinter groups may form. But if public services have the cost structure of pure public goods, then there is no reason for a splinter group to form, since the public authority always prefers a greater aggregate provision, since it accounts for all residents' willingness to pay, rather than only a splinter group's.

Of course, if the cost structure is more like a private good than a public good, there is the question of why the public is involved at all. Why isn't every resident responsible for his own education and health care? One possible answer is externalities. If there are external benefits to a high level of health care (as, for example, when there are contagious diseases) or a high level of education (when, for example, education prevents crime or reduces public assistance), then the public should force a higher level of consumption than individuals would choose. In that case, the public authority might want to prohibit private supplements by high-demand residents, precisely on grounds that it reduces consumption of the public service by low-demand residents.

Another reason for public involvement is that taxing to provide public services gives an opportunity for redistributing income by imposing different tax shares. Epple and Romano (1996c) investigate a model of a publicly-provided private good such as health care, funded by redistributive income taxes. The tax share is higher for high-income residents even though the resource cost is the same for every resident served. The level of public services and the amount of redistribution are both controlled by a single policy lever, the tax rate. This policy lever is established by vote, rather than by a welfare-maximizing manager as above. Epple and Romano compare regimes where the private good is publicly provided, privately provided, and publicly provided with discretionary private supplements. They show that the latter is preferred by a majority who simultaneously vote on the tax rate and the regime. Their argument uses the fact that, at a given tax rate, everyone prefers allowing discretionary private supplements. This is for much the same reason as in the example above, with the twist that funding through an income tax has a redistributive element. High-income residents want to supplement the public provision because they can increase their services without increasing their subsidies. Low-income residents are indifferent to subsidization, and want at least some government provision, because the income tax system gives them an implicit subsidy from high-income residents.

The above example concerns private *supplements* to publicly provided services. In the case of schools, the private supplement would pay for after-school activities. In the case of health care, the supplement would pay for better specialists. In addition, there are private *alternatives* to public provision. It is possible that an agent will opt out of the public system entirely, and choose a private alternative. See, for example, Ireland (1990), Epple and Romano (1996a) and Glomm and Ravikumar (1998). Of course, opting out of the public offering does not typically allow the resident to escape taxation, so the preferences for public services are again combined with the desire to avoid or exploit redistributive taxes. The dual purposes of the policy lever create difficulties in sorting out preferences. An important consequence of the right to opt out is that preferences over public tax/expenditure packages are not single-peaked. Epple and Romano (1996a) summarize previous work on this subject, and extend it in an interesting way. They show that typically it is the low-income (low-demand) residents, together with the high-income (high-demand) residents who will oppose tax increases, whereas the middle class both uses the publicly provided service, and prefers higher taxes and higher provision.

Models of the private–public interface in the spirit of club theory have been built around the contentious subject of private supplements to public education. As in club theory, it is assumed that students confer externalities on each other in small groups (schools). If students differ in ability, achievement may depend on "peer group" effects, often captured by the mean ability of the student's school. Prices to internalize the externality, as described in Section 2 above, are not allowed in the public system. Consequently equilibrium is inefficient and might not exist. The peer groups idea was introduced by Arnott and Rowse (1987), who modeled the optimal partition into schools as a tradeoff between demand for good schools, which depends on income, and efficient provision of peer-group externalities, which depends on ability. See also Brueckner and Lee (1989). Epple and Romano (1996b) analyze a similar model from an equilibrium perspective, pointing out that public schools with no flexibility in pricing will end up with the low-ability and low-income students, while students with high income, high ability or both will end up in private schools. Private schools will price so that students with high income and low ability, who demand good peers, will cross subsidize students with low income and high ability. Public schooling introduces an inefficiency by not pricing in a way that internalizes peer-group externalities. Poor kids with high ability can be lifted out of poverty by the self-interested tuition policies of private schools trying to create peer-group effects. However Fernandez and Rogerson (1995) give a reason to be skeptical about public subsidies to education when it is only partially subsidized. They point out that because there must be a private supplement, high-income residents are more likely to take advantage of the subsidy, which therefore becomes a transfer from the poor to the rich.

There is another body of literature on education which focuses on the inefficiencies that arise because of second-best pricing policies, but does not concern itself with the public–private interface. In the free-mobility model of Fernandez and Rogerson (1996), the equilibrium level of education is determined by the average income in groups. They show that, due to income taxation, the population will typically end up partitioned such that the average income (hence average achievement) in two jurisdictions could both by increased by moving some people from a wealthy community to a poorer one. They investigate policies to undo that inefficiency.

Benabou (1993) introduces the notion that there are two types of externalities in the education environment. First, an environment with many highly skilled workers makes it cheaper to become skillful. In addition, the productivity of agents with different types of skills depends on their relative numbers. The two types of externalities interact in complex ways, but in particular there is no way to augment the reward for becoming highly skilled to reflect the externality it confers in the education process. Consequently highly skilled agents might want to form homogeneous communities even though, for efficiency, they should mix with less skilled agents in order to create positive externalities. Similar ideas are developed by Benabou (1996a,b).

6. Some new ideas

In this chapter I have tried to focus on ideas that have emerged since the previous handbook articles. Some of the new ideas do not fit easily into the categories above, so I include them separately.

The section above on the local objective function takes a rather normative view. It asks what the local objective function *should* be in order that the economy achieves efficiency in consumers' location choices and provisions of local services. A completely different idea is proposed by Glomm and Lagunoff (1998). Instead of assuming that jurisdictions compete in their provisions of local public goods and taxes, they assume that jurisdictions compete in the *rules* for choosing local public goods and taxes. In particular, they assume that one jurisdiction offers residents the opportunity to make voluntary contributions to the local public goods, and that another lets the residents vote on the level of local public goods, funding it with coercive income taxes. They show circumstances in which either both communities or only one can survive. Although the two proposed rules do not seem particularly realistic, the idea that jurisdictions compete in their institutional arrangements is an interesting one.

It has long been recognized that spillovers between geographic jurisdictions are rampant. Residents of one jurisdiction might visit the local facilities of another jurisdiction, such as museums, and are harmed by pollution spillovers such as acid rain. The local objective functions described in Section 4 would not account for such spillovers. However, Jehiel (1997) introduces the idea that local public goods with spillovers are established by a bargaining process in which jurisdictions can swap externalities and establish their local public goods cooperatively. Nevertheless, because of migration between the jurisdictions, he finds that the local public goods will not be provided efficiently. The result depends on some specific assumptions about bargaining and instruments of reciprocity, but opens a new line of inquiry about whether such bargaining should be restricted or encouraged.

An area where local public economics and political economy overlap is in trying to understand the formation of markets. Group formation can affect trade either because of complementarities between private goods and the public services or other features of the group (see Example 4 above), or because the public services themselves facilitate trade [Casella (1992), Casella and Feinstein (2001)].

None of the above models of local public goods describes the migration features that nations actually employ. The club model is not a good approximation to jurisdiction formation because jurisdictions do not use the kind of externality-based pricing required by Example 2, because there is no free entry, because jurisdictions are not profit maximizers, and because of the bundling discussed in Section 3. The free mobility notion is a good approximation to relationships between sub-jurisdictions such as states in the USA and provinces in Canada, but the theory is very limited. At the level of nations themselves, migration is severely restricted. None of the models above explains why this should be so. Is there an efficiency reason that the intra-country rules for migration should be different from the inter-country rules for migration? This question has not been addressed, but a related question is what should be the rules of migration among states if they could be set constitutionally within a nation. Jehiel and Scotchmer (2001) introduce three new migration rules, and compare them with free mobility. These are (i) admission by majority vote, (ii) admission by unanimous consent, and (iii) admission with public good demands above a threshold.

Neither the club model nor free mobility adequately describes secession. Alesina and Spolaore (1997) and LeBreton and Weber (2000) explore a hybrid type of model which permits coordinated deviations, but possibly with restrictions on side payments. Instead of voting on the level at which a public service will be provided, the residents vote on the location of a ”capital city”. Each agent’s preferred location is near his residence, in order to minimize transportation costs, and the median voter will get his preferred location. If a group of unfavored agents secedes (those who are distant from the capital city), they can locate a new capital city closer to their own residences. The objective of these papers is to explain when a country will be immune to secession, and also to explain the distribution schemes that will create stability. LeBreton and Weber show that side payments can be used to create stability, and stability will require side payments such that agents’ utility declines with distance from the capital city. That is, the distant agents are somewhat “bribed” not to secede, but not so much that wellbeing is entirely equalized. Those located close to the capital city are still better off than those located far away.

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