Taste-homogeneity of Optimal Jurisdictions†
in a Tiebout Economy with Crowding Types

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Abstract

We consider a new model of a local public goods economy with differentiated crowding in which we make a distinction between the tastes and crowding characteristics of agents. It is possible in this model to have taste-homogeneous jurisdictions that take advantage of the full array of positive crowding effects (labor complementarities, for example.) We nevertheless find that taste-heterogeneous jurisdictions are sometimes strictly superior to taste-homogeneous jurisdictions with the same crowding profile. We also provide an example which illustrates the difficulties in extending the intuitive results from the hedonic pricing literature to Tiebout economies with differentiated crowding.

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1. Introduction

Tiebout's (1956) great contribution to public economics was his hypothesis that when public goods are "local", competition between jurisdictions would induce agents to reveal their preferences. He reasoned that jurisdictions would offer competing bundles of local public goods and tax liabilities, and that agents would find it in their best interests to move to the jurisdiction which most closely approximated their ideal combination. Tiebout concluded that the free rider problem disappears in local public goods economies.

Another insight offered by Tiebout is that in an economy with a large number of jurisdictions offering a wide variety of packages of public goods, there will be tendancy for optimal jurisdictions to consist of agents with similar tastes. Mixing different types of agents together seems to require compromise between conflicting tastes. Segregating agents according to tastes, therefore, seems to be Pareto improving.

For local public goods economies with anonymous crowding[1] this intuition is essentially correct. Wooders (1978) shows that in this case optimal jurisdictions will always include agents with the same *demands* for public goods and crowding.[2] Note that this is not identical to proving that taste-homogeneity is a necessary condition for optimality since, given prices, agents with different preferences may demand the same quantities of crowding characteristics and public goods levels. The fact that optimal jurisdictions in anonymous crowding economies must be demand-homogeneous does imply, however, that taste-heterogeneous jurisdiction can never Pareto dominate taste-homogeneous jurisdictions. In other words, while in some

[1] Anonymous crowding means that agents do not differentiate between other agents on the basis of their tastes and other characteristics. They are affected only by the number of agents with whom joint production and/or consumption is carried out.

[2] Also see Berglas and Pines (1980), Scotchmer and Wooders (1987) and Barham and Wooders (1994).

circumstances it does no harm to mix agent types together, there is never any benefit from doing so.

The situation is much less clear in the case of differentiated crowding. When agents care not only about the number of agents in a jurisdiction, but also about their types, then it may indeed be optimal for agents of different types to mix. For example, optimal symphony orchestras do not employ violinists alone. Although homogeneity is not optimal in general, it is still possible to make some progress by narrowing the question. For example, Brueckner (1992) investigates whether or not mixing of types is optimal when crowding effects are positive and take the form of labor complementarities in production. He shows that if complementarities between types are sufficiently weak, then optimal jurisdictions will consist of individuals with the same demands.[3]

A reason that homogeneity results have been difficult to obtain in the differentiated crowded model is that these models link the effect an agent has on the other members of his jurisdiction to his preference mapping. In some sense, these models seem to be saying that all violinists have the same tastes. It is hard to understand the motivation for this linkage. On the other hand, it does seem plausible that an optimal orchestra would contain musicians with many different talents, but with the same preferences. For example, it should be optimal to place all musicians who like to practice in the morning in one orchestra and those who like to practice at night in another. This point is made forcefully in Berglas (1976). It is impossible to study this question in any generality, however, until a formal distinction is made between tastes and other types of characteristics.

With this in mind, Conley and Wooders (1994a) introduced a model which explicitly makes a separation between agents' tastes and their crowding characteristics. The taste type of an agent is described by his preferences and endowment,

[3] McGuire (1991) examines a similar question graphically.

which are assumed to be private information. The crowding type of an agent determines the effects he has on others, and is assumed to be publicly observable. For example, men and women may crowd each other differently at a dance. Here, gender is a publicly observable crowding characteristic. On the other hand, some dancers like rock and others like country. These are taste characteristics and are private information. Epple and Romano (1994) make a similar distinction in a more applied context, which we discuss in more detail below. The main result in Conley and Wooders (1994a) is that the core is equivalent to the set of Tiebout equilibrium with *anonymous prices*. That is, the core can be decentralized by a set of prices which do not depend on the tastes of agents. This contrasts with the existing literature on the differentiated crowded in which decentralizing prices depend on the tastes of agents.[4]

When we separate crowding and taste types, complementarities between crowding types no longer provide a reason for agents with different tastes to mix. The strong suggestion from the literature is that optimal jurisdictions should be demand-homogeneous in this case. That is, jurisdictions which contain agents with a single taste type, but possibly with several different crowding types, should always be able to make agents at least as well off as they would be in a jurisdiction where several different taste types are mixed together.

The main point of this paper is the somewhat surprising result that even when crowding and taste characteristics are distinguished from one another, in general optimal jurisdictions still will not be demand-homogeneous. Even though it possible to take advantage of the full range of crowding characteristics while segregating according to preferences, in some cases it will be optimal for agents to mix across taste types. We provide examples which demonstrate that this is true regardless of

[4] We argue in Conley and Wooders (1994b) that unless the efficient allocations are decentralized through anonymous prices, there is no meaningful confirmation of the basic Tiebout hypothesis that agents can be induced to reveal their preferences through their market behavior when public goods are local.

whether crowding takes place in production or consumption. We are able, however, to prove a somewhat weaker homogeneity result. Specifically, we show that there is no benefit from having agents of several taste types but of the same crowding type in a single jurisdiction. For example, we may find men who like country music at a dance with women who like rock, but we should not expect, in general, to find women who like rock at the same dance with women who like country.

The plan of this paper is as follows. In section two, we formally describe the crowding types model. In section there, we discuss the homogeneity properties of this model. In section four, we show that the value of the characteristics an agent possesses (his taste and crowding type) are not independent; the utility an agent receives in the core can be decomposed as a wage paid separately each of these two characteristics. Thus, hedonic decentralization in the spirit Lancaster (1966) and Rosen (1974) is in general not possible in the crowding types model.

2. The Model

Agents are defined by two characteristics. There are T different sorts of tastes or preference maps, denoted by $t \in \{1, \ldots, T\} \equiv \mathcal{T}$, and C different sorts of crowding types, denoted $c \in \{1, \ldots, C\} \equiv \mathcal{C}$. We assume no correlation between c and t. The tastes of an individual are assumed to be private information and not to directly affect the welfare or production possibilities of others. Crowding type is publicly observable and enters into jurisdictional production functions and other agents' preference mappings.

The population of agents is denoted by $N = (N_{11}, \ldots, N_{ct}, \ldots, N_{CT})$, where N_{ct} is interpreted as the total number of agents with crowding type c and taste type t in the economy. A *jurisdiction* is a group of agents who collectively produce and consume a common level of public good. A jurisdiction is represented by a vector $m = (m_{11}, \ldots, m_{ct}, \ldots, m_{CT})$, where m_{ct} is interpreted as the number of agents with crowding type c and taste type t in the jurisdiction m. The set of all feasible jurisdictions is denoted by $\mathcal{N}$. We will say that two jurisdictions, m and $\hat{m}$, have the *same crowding profile* if for all $c \in \mathcal{C}$, $\sum_t m_{ct} = \sum_t \hat{m}_{ct}$. That is, two jurisdictions have the same crowding profile if the number of agents of any given crowding type is the same in both jurisdictions. A *partition* $n = \{n^1, \ldots, n^K\}$ of the population is a collection of jurisdictions such that $\sum_k n^k = N$. It will sometimes be necessary to refer to individual agents $i \in \{1, \ldots, I\} \equiv \mathcal{I}$. Observe that $I = \sum_{c,t} N_{ct}$. Let $\theta : \mathcal{I} \to \mathcal{C} \times \mathcal{T}$ be a function that indicates the type of a given individual. Thus, if agent i is of crowding type c and taste type t, then $\theta(i) = (c, t)$. With a slight abuse of notation, if individual i is a member of jurisdiction m, we shall write $i \in m$. We will also write $n^k \in n$ when a jurisdiction of type n^k is in the partition n.

We consider an economy with one private good and L public goods. We assume that agents can be members of only one jurisdiction at a time. Each agent $i \in \mathcal{I}$ of taste type t is endowed with $\omega_t \in \Re_+$ of the private good, and has a complete and transitive preference ordering[5] $\succeq_t$ over $\Re_+ \times \Re_+^L \times \mathcal{N}$. The strong preference relation $\succ_t$, and the indifference relation $\sim_t$ are defined in the usual way from $\succeq_t$. We do not require preferences to satisfy convexity, monotonicity, and continuity. We only need the relation to satisfy a condition called *Taste Anonymity in Consumption* (TAC):

TAC: for all $m, \hat{m} \in \mathcal{N}$, if for all $c \in \mathcal{C}$ it holds that $\sum_t m_{ct} = \sum_t \hat{m}_{ct}$ then for all $x \in \Re_+$, all $y \in \Re_+^L$, and all $t \in \mathcal{T}$ it holds that $(x, y, m) \sim_t$

[5] Formally, this implies that agents with the same tastes but different crowding characteristics have the same endowments. This is without loss of generality since there is no requirement that agents of taste type t have different preferences from agents of type t'. Thus, we can consider agents of the same crowding type with the same preferences but different endowments to be different taste types. Completeness and transitivity are probably not required for the results that follow, but they make the theorems more transparent.

$(x, y, \hat{m})$.

This is a formal statement of the idea that agents care only about the crowding types and not the taste types of the agents in their jurisdiction. It is probably more appropriate to view this, and (TAP), below, as defining the meaning of crowding types rather than as a restriction on preferences or production, respectively.

The set of feasible production plans is given by a set

$$P \subset \Re \times \Re_+^L \times \mathcal{N}.$$

We say (z, y) is a feasible plan for a jurisdiction with composition m if $(z, y, m) \in P$. Again, we do not impose any condition of convexity, closedness or monotonicity on the production set. In keeping with the spirit of the model, we assume that only the crowding profile of agents in a jurisdiction affects the cost of producing public good. We call this *Taste Anonymity in Production* (TAP).

TAP: for all $m, \hat{m} \in \mathcal{N}$, if for all $c \in \mathcal{C}$ it holds that $\sum_t m_{ct} = \sum_t \hat{m}_{ct}$ then for all $z \in \Re_+$, and all $y \in \Re_+^L$ such that $(z, y, m) \in P$ it holds that $(z, y, \hat{m}) \in P$.

The assumptions TAC and TAP are maintained in all that follows and no further mention of them will be made. A *feasible state of the economy* (X, Y, n) is a partition n of the population, an allocation $X \equiv (x_1, \ldots, x_I) \in \Re^I$ of private good, and public good production plans $Y \equiv (y^1, \ldots y^K) \in R^{KL}$ such that for each $n^k \in n$ there exists $z^k \in \Re$ satisfying

$$(z^k, y^k, n^k) \in P$$

and

$$\sum_k \sum_{c,t} n_{ct}^k \omega_t + \sum_k z^k = \sum_i x_i.$$

We denote the set of feasible states by F.

A jurisdiction $m \in \mathcal{N}$ producing a feasible plan $(z, y, m) \in P$ *improves upon* a feasible state $(X, Y, n) \in F$ if there exists some $x \equiv \{x^i\}_{i \in m}$ such that

1. $\sum_{ct} m_{ct}\omega_t + z = \sum_{i \in m} x_i$,
2. for all $i \in m$ it holds that $(x_i, y, m) \succeq_t (x_i^k, y^k, n^k)$, where $\theta(i) = (c, t)$ for some $c \in \mathcal{C}$ and agent $i \in n^k \in n$ in the original feasible state and,
3. for some $j \in m$ it holds that $(x_j, y, m) \succ_{\hat{t}} (x_j^{\hat{k}}, y^{\hat{k}}, n^{\hat{k}})$, where $\theta(j) = (\hat{c}, \hat{t})$ for some $\hat{c} \in \mathcal{C}$ and, in the original feasible state, agent $j \in n^{\hat{k}} \in n$

A feasible state $(X, Y, n) \in F$ is in the *core* of the economy if it cannot be improved upon by any jurisdiction.

We consider economies in which small groups are effective. An economy with population N satisfies *Strict Small Group Effectiveness*, (SGE),[6] if there exists a positive integer B such that,

1. for all positive integers α and economies with population $\alpha N \equiv N'$, if a state (X, Y, n) is feasible for the economy with population N' and can be improved upon, then also there exists a jurisdiction $m \in \mathcal{N}'$ with $\sum_{c,t} m_{ct} \leq B$ that can improve upon (X, Y, n), and
2. for all $c \in \mathcal{C}$ and $t \in \mathcal{T}$, either $N_{ct} > B$ or $N_{ct} = 0$.

The first condition says that for replications of the economy, any state that can be improved upon at all can be improved upon with a jurisdiction containing at most B agents. In other words, small groups are effective in the sense that no new opportunities for coalitional improvement would arise if the economy were to grow proportionally. The second condition says that if there are any agents at all of a given type in the economy, then there are at least B of them. In other words, no type that appears in the economy is scarce.

The next lemma establishes that if SGE holds, then any replication of a state

[6] See Wooders (1994) or Conley and Wooders (1994b) for a discussion relationships between various conditions of small group effectiveness and references.

of the economy in the core is in the core of the replicated economy.[7]

Lemma 1. *Let (X, Y, n) be a core state of an economy satisfying SGE and having population N. Then for any given positive integer, α,*

$$(\overbrace{X, \ldots, X}^{\alpha \text{ times}}, \overbrace{Y, \ldots, Y}^{\alpha \text{ times}}, \overbrace{n, \ldots, n}^{\alpha \text{ times}}) \equiv (X', Y', n'),$$

is a core state for an economy with population $\alpha N \equiv N'$.

Proof/

Suppose instead that (x, y, m) improves upon (X', Y', n'). By SGE, if a feasible state can be improved upon it can be improved upon by a jurisdiction with B agents or fewer. Thus, without loss of generality, assume that $\sum_{c,t} m_{ct} \leq B$. But by SGE, the original economy N contains at least B agents of each type that appears in the jurisdiction m, and so this is a feasible jurisdiction for the original economy. We conclude that if (x, y, m) improves upon (X', Y', n') then (x, y, m) improves upon (X, Y, n), contradicting the hypothesis that (X, Y, n) is in the core.

■

We show next that SGE implies that two agents with the same taste type and crowding type must be exactly as well off as each other in any core state. That is, the core has the equal treatment property.

Lemma 2. *Let (X, Y, n) be a core state of an economy satisfying SGE and having population N. For any two individuals $i, \hat{\imath} \in \mathcal{I}$ such that $\theta(i) = \theta(\hat{\imath}) = (c, t)$, if $i \in n^k \in n$ and $\hat{\imath} \in n^{\hat{k}} \in n$ then $(x_i^k, y^k, n^k) \sim_t (x_{\hat{\imath}}^{\hat{k}}, y^{\hat{k}}, n^{\hat{k}})$.*

Proof/

Suppose not. Without loss of generality, assume $(x_i^k, y^k, n^k) \succ_t (x_{\hat{\imath}}^{\hat{k}}, y^{\hat{k}}, n^{\hat{k}})$.

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[7] Lemmata and , and Theorem , below, extend results in Conley and Wooders (1994a) to nontransferable utility economies with an finite number of public goods.

1. Suppose first that individuals i, and $\hat{i}$ are in different jurisdictions. Consider the coalition consisting of agent $\hat{i}$ and of all the agents in n^k except agent i. Call this jurisdiction in which i is replaced by $\hat{i}$, m. Let the private goods allocation be as follows: for all $j \neq \hat{i}$, $x_j \equiv x_j^k$, and for agent $\hat{i}$, $x_{\hat{i}} \equiv x_i^k$. Since the crowding profile is the same for these two jurisdictions, by (TAP)

$$(z, y^k, m) \in P.$$

where $\sum_{ct} m_{ct}\omega^t - \sum_{i \in m} x_i \equiv z$. In other words, (x, y^k) is feasible for the jurisdiction m. Then by (TAC) for all $j \in m$ such that for some $\tilde{c} \in \mathcal{C}$, it holds that $\theta(j) = (\tilde{c}, \tilde{t})$, we have

$$(x_j, y^k, m) \succeq_{\tilde{t}} (x_j^k, y^k, n^k),$$

and, for agent $\hat{i}$,

$$(x_{\hat{i}}, y^k, m) \succ_t (x_{\hat{i}}^k, y^k, n^k).$$

Thus, the jurisdiction m is able to improve upon (X, Y, n), contradicting the fact that this state is in the core.

2. Suppose instead that i and $\hat{i}$ are in the same jurisdiction in the core state. Since the economy satisfies SGE, by Lemma ,

$$(\overbrace{X, \ldots, X}^{\alpha \text{ times}}, \overbrace{Y, \ldots, Y}^{\alpha \text{ times}}, \overbrace{n, \ldots, n}^{\alpha \text{ times}}) \equiv (X', Y', n')$$

is a core state for an economy with population $\alpha N \equiv N'$. But then there must be two individuals i and $\hat{i}$ of crowding type c and taste type t in the replicated economy who reside in different jurisdictions and receive different utility levels. Then by the same argument given in (1) above, this state could be improved upon, contradicting the fact that it is in the core.

■

The next theorem is especially important. It says that SGE implies that in all core states, in any given jurisdiction, the implicit private goods contribution of a given crowding type to public goods provision is the same across all taste types. In other words, the implicit admissions prices to jurisdictions in the core states are anonymous in the sense that they depend only on crowding characteristics and not on tastes of agents.

Theorem 1. *Let (X, Y, n) be a core state of an economy satisfying SGE and having population N. Suppose that for some jurisdiction $n^k \in n$, for some crowding type $c \in \mathcal{C}$, and for two taste types $t, \hat{t} \in \mathcal{T}$, $n^k_{ct} > 0$, and $n^k_{c\hat{t}} > 0$. Then for all $i, \hat{i} \in n^k$ such that $\theta(i) = (c, t)$ and $\theta(\hat{i}) = (c, \hat{t})$, it holds that $\omega_t - x^k_i = \omega_{\hat{t}} - x^k_{\hat{i}}$.*

Proof/

Suppose not. Without loss of generality, assume $\omega_t - x^k_i > \omega_{\hat{t}} - x^k_{\hat{i}}$.

1. Suppose first that there exists a jurisdiction $n^{\tilde{k}} \in n$ satisfying $\tilde{k} \neq k$ such that for some individual $\tilde{i} \in n^{\tilde{k}}$ it is the case that $\theta(\tilde{i}) = (c, t)$. Since $\tilde{i}$ has the same crowding type as $\hat{i}$, by (TAC) the other members of jurisdiction n^k are indifferent to agent $\tilde{i}$ replacing agent $\hat{i}$ if $\tilde{i}$ contributes at least $\omega_{\hat{t}} - x^k_{\hat{i}}$ to public good production. But by Lemma , all agents of any given type (c, t) are equally treated in the core. Therefore, since agent i would be willing to join jurisdiction n^k and contribute $\omega_t - x^k_i$, and i and $\tilde{i}$ are of the same crowding and taste type, agent $\tilde{i}$ must be exactly as well off when he moves to jurisdiction n^k and contributes $\omega_t - x^k_i$ as he was in jurisdiction $n^{\tilde{k}}$. But $\omega_t - x^k_i - (\omega_{\hat{t}} - x^k_{\hat{i}}) > 0$, so it is possible to distribute this surplus over the agents now in the jurisdiction to make them better off than they were in the core state, a contradiction.
2. Suppose instead that there is no jurisdiction $n^{\tilde{k}} \in n$ satisfying $\tilde{k} \neq k$ such that for some individual $\tilde{i} \in n^{\tilde{k}}$ it is the case that $\theta(\tilde{i}) = (c, t)$. Since the economy satisfies SGE, by Lemma ,

$$(\overbrace{X, \ldots, X}^{\alpha \text{ times}}, \overbrace{Y, \ldots, Y}^{\alpha \text{ times}}, \overbrace{n, \ldots, n}^{\alpha \text{ times}}) \equiv (X', Y', n')$$

is a core state for an economy with population $mN \equiv N'$. But then by construction such a jurisdiction $n^{\tilde{k}}$ exists in the replicated economy. By the same argument given in (1) above, this state could be improved upon by a jurisdiction, contradicting the fact that it is in the core.

■

Note that the ease with which Theorem is proved is a consequence of the assumption that there is only one private good. In the case of an arbitrary finite number of private goods and strict convexity of preferences, however, an analogous result holds asymptotically.

3. Homogeneity

The central question we address in this paper is whether or not agents can do at least as well in taste-homogeneous jurisdictions as in taste-heterogeneous jurisdictions in the core. In other words, for every jurisdiction n^k in a core state of the economy, does there exists a taste homogeneous jurisdiction m with the same crowding profile which makes all of its members at least as well off as they were in the core jurisdictions from which they came? Formally, given a core state (X, Y, n), a jurisdiction m said to be *Pareto equivalent* to a jurisdiction $n^k \in n$ in the core state if for some allocation (x, y),

1. for all $i \in m$ it holds that $(x_i, y, m) \succeq_t (x_i^{\hat{k}}, y^{\hat{k}}, n^{\hat{k}})$, where $\theta(i) = (c, t)$ and, in the core state, $i \in n^{\hat{k}} \in n$,
2. for all $c \in \mathcal{C}$ it holds that $\sum_t n_{ct}^k = \sum_t m_{ct}$ and
3. $((\sum_{i \in m} x_i - \sum_{c,t} m_{c,t}\omega_t), y, m) \in P$.

Condition (1) requires that agents are at least as well off in the new jurisdiction m as they were in the jurisdiction to which they were assigned in the core state.

Condition (2) requires that Pareto equivalent jurisdictions have the same crowding profile. Condition (3) requires that the allocation provided by the new jurisdiction m be feasible.

Intuition from the existing literature strongly suggests that we should be able to find Pareto equivalent and taste-homogeneous jurisdictions for every jurisdiction in the core. In our model there is no tension between the gains from trade motivation to mixing with workers with different labor skills, and the gains to specialization motivation to mix only with agents who share the same tastes for public goods in the crowding types model described in section two. Taste-homogeneous jurisdictions containing a full array of crowding types are feasible. It comes as something of a surprise, therefore, that such Pareto equivalent jurisdictions will not, in general, exist.

Consider the following simple matching problem. Matching problems are a special case of the model presented in this paper. They are simpler in that agents receive utility only through the agent with whom they are partnered, and not explicitly through private or public consumption. We emphasize that the general proposition that there need not exist Pareto equivalent and strongly taste-homogeneous jurisdictions for every jurisdiction in a core state in no way depends on this simplification.

Example 1. Nonoptimality of taste-homogeneous jurisdictions with crowding in consumption.

Suppose there are two crowding types, Smokers and Nonsmokers, denoted S and N, respectively. Also suppose there are two taste types, Lovers and Haters of second hand smoke, denoted L and H, respectively. Assume agents of all four possible types, denoted $SL, SH, NL,$ and NH, appear in equal proportion in the population. The utility functions are the following:

$$U^H(\{S,S\}) = 0, \quad U^L(\{S,S\}) = 10,$$

$$U^H(\{S,N\}) = 5, \quad U^L(\{S,N\}) = 5,$$

$$U^H(\{N,N\}) = 10, \quad U^L(\{N,N\}) = 0,$$

and the utility received from being in every other possible type of jurisdiction is zero. This implies the following characteristic function for the associated game:

$$\Gamma(\{SL,SL\}) = \Gamma(\{NH,NH\}) = 20$$

$$\Gamma(\{SH,NL\}) = \Gamma(\{SL,SH\}) = \Gamma(\{SL,NL\}) = 10$$

$$\Gamma(\{SL,NH\}) = \Gamma(\{SH,NH\}) = \Gamma(\{NL,NH\}) = 10$$

$$\Gamma(\{SH,SH\}) = \Gamma(\{NL,NL\}) = 0,$$

and zero for every other jurisdiction type. Observe that anything that can be improved upon can be improved upon by two person jurisdictions. Thus, if at least two agents of each type appear in the population, SGE is satisfied. Now consider the case where the population consists of two of each of the four agent types. One core state consists of one jurisdiction each with compositions: $\{SL,SL\},\{NH,NH\}$, and two jurisdictions with composition: $\{SH,NL\}$, with agents of type SL and NH receiving ten units of utility, and agents of type NL and SH receiving five units of utility. It is easy to check that this state cannot be improved upon.

We claim that it is not possible to find a taste-homogeneous and Pareto equivalent jurisdiction for any mixed jurisdictions in this core state. Take a jurisdiction with composition $\{SH,NL\}$ for example. Suppose we tried to taste-homogenize this jurisdiction by replacing the agent of type NL with one of type NH. This coalition receives a payoff of ten in total. The sum of the core payoffs to these agents is fifteen. Thus, it is impossible to make these agents as well off in the taste-homogeneous coalition as they are in the core state. It is easy to check that any other effort to taste-homogenize the mixed jurisdictions fails in the same way. We conclude that such taste-homogeneous Pareto equivalent jurisdictions do not exist in general

This is an unexpected conclusion, so it is important to develop some intuition for what is diving this result. The example shows that it is optimal for smoking/haters of second hand smoke, SH, to mix with nonsmoking/lovers of second hand smoke, NL. Taste-homogenizing this jurisdiction, for example by replacing the "nonsmoking/lover" with an "nonsmoking/hater", is not Pareto improving. The "smoking/hater" is made no better off by this change, and clearly it is better to match a smoker with lover of second hand smoke than with a hater of second hand smoke. In other words, the intuition that there are complementarities between agents with the same tastes which should make taste-homogeneous jurisdictions optimal is incomplete. It ignores the possibility that there might also be additional complementarities between two different sets of taste and crowding characteristics. That is, a pair of characteristics (c, t) might be complementary to a pair (c', t'). It is not sufficient to consider complementarities within a given taste type, and between various crowding types independently. In the example, a smoking/hater would like to find a nonsmoker, and a nonsmoking/lover would like to find a smoker. These two agent types are therefore complementary, and this complementary outweighs the motivation to find an agent with the same tastes.[8]

This reflects similar results in Epple and Romano (1994) who example a model of optimal school formation. They distinguish between the tastes of agents (proxied by income) and crowding characteristics (the quality of a given student which provides positive "peer group" effects). They also discover that taste-heterogeneous clubs may be optimal. In particular, they find a complementarity between high-quality low-income students and low-quality high-income students. They show that

[8] Since there is no public good choice and coalition size is fixed at two by construction, the motivation to segregate by tastes in this example is zero, the lowest it could possibly be.

is in the best interests of both types of agents for low-quality high income students to subsidize the education of low-income high-quality students.[9]

Crowding takes place only in consumption in example one. It is natural to wonder if a similar result can be obtained when crowding occurs only in production. This is more in the spirit of Brueckner's (1994) model. It turns out the answer is no, as the following example demonstrates.

Example 2. Nonoptimality of taste-homogeneous jurisdictions with crowding in production.

Suppose that the world consists of carpenters (C) and brick masons (M). Two agents live on each residential block, and they will always choose to build a fence between their properties (the simplification that only two agents live on each block allows us to restrict attention to two agent coalitions only). These fences can be made of planks, adobe, or brick. There are two taste types: wooden fence lovers (W) and brick fence lovers (B). The cost of constructing a various types of fences with particular combinations of residents is given in the following table:

Composition	None	Plank	Adobe	Brick
CC	0	50	150	200
CM	0	150	50	150
MM	0	200	150	50

For example, two carpenters can construct a plank fence at a cost of 50 units of transferable utility. The utility an agent receives depends on his taste type and the type of fence that he helps build according to the following table.

[9] They also find that the implicit pricing system as reflected by the core contributions of agents to fund schools are asymptotically anonymous for large economies. Specifically, they show that within a given school, all agents with the same tastes (income) pay the same amount in the limit. This reflects the results of Conley and Wooders (1994a).

Taste type	None	Plank	Adobe	Brick
W	0	110	100	90
B	0	90	100	110

Thus, crowding takes place only in production. Agents are not affected by the other agents except in as much as they change to cost of constructing the public good. These tables allow us to derive the total utility that every possible pair of neighbors could obtain.

Jurisdiction Composition	Optimal Fence	Total Utility
MW and MW	Brick	130
MW and MB	Brick	150
MW and CW	Adobe	150
MW and CB	Adobe	150
MB and MB	Brick	170
MB and CW	Adobe	150
MB and CB	Adobe	150
CW and CW	Plank	170
CW and CB	Plank	150
CB and CB	Plank	130

Now suppose that there are one hundred of each of the four types. As before, two agent coalitions can improve upon any state that is not in the core, and so SGE is satisfied. The core state is for 50 $\{MB, MB\}$, 50 $\{CW, CW\}$, and 100 $\{MW, CB\}$ jurisdictions to form where MB and CW types each receive 85 units of utility and MW and CB type each receive 75 units of utility. It is easy to verify that such jurisdictions cannot be improved upon. More importantly, homogenizing these jurisdictions across tastes leads to utility loss. A jurisdiction with one MW and one CW, for example, receives only 150 units of utility, which is less than the 160 units they receive in total in the core state. Thus, we find that taste-heterogeneous jurisdictions may be able to provide their members with a higher utility level than taste-homogeneous one regardless of whether crowding occurs in consumption or production.

Although strongly taste-homogeneous jurisdictions are not necessarily optimal in the crowding types model, it is possible to prove a somewhat weaker result. A jurisdiction m is said to be *weakly taste-homogeneous* if for every $c \in \mathcal{C}$ with $m_{ct} > 0$ for some $t \in \mathcal{T}$, for all $\tilde{t} \neq t$ it holds that $m_{c\tilde{t}} = 0$. In words, a jurisdiction is weakly taste-homogeneous if within each crowding type there is taste-homogeneity, but agents with different taste types may still be in the same jurisdictions provided they are of different crowding types. In example (1) above this means there would never be an advantage to mixing agents of type NH, and NL is the same jurisdiction, but it might be the case that all core states must include jurisdictions that mix agents of type NH and SL together.

The next theorem says that if SGE is satisfied, then in every core allocation, agents always do at least as well in weakly taste-homogeneous jurisdictions as in any sort of taste-heterogeneous jurisdictions.

Theorem 2. *Suppose that an economy satisfies SGE. Then, given a core state $(X, Y, n) \in F$, for every jurisdiction $n^k \in n$, such that there exists a weakly taste-homogeneous jurisdiction $m \in \mathcal{N}$ with the same crowding profile, it holds that m is Pareto equivalent to n^k.*

Proof/

We construct the allocation for jurisdiction m as follows By hypothesis, for every $\hat{i} \in m$, such that $\theta(\hat{i}) = (c, t)$, there exists an individual $i \in n^k$ such that $\theta(i) = (c, t)$. For all such individuals i, set $x_{\hat{i}} = x_i^k$. By theorem , if for some crowding type $c \in \mathcal{C}$, and two taste types $t, \tilde{t} \in \mathcal{T}$, $n_{ct}^k > 0$, and $n_{c\tilde{t}}^k > 0$, then for all

$i, \tilde{i} \in n^k$ such that $\theta(i) = \{c, t\}$ and $\theta(\tilde{i}) = \{c, \tilde{t}\}$, it holds that $\omega_t - x_i^k = \omega_{\tilde{t}} - x_{\tilde{i}}^k$. Since n^k and m have the same crowding profiles, it follows by construction and theorem that

$$\sum_{c,t} n_{ct}^k \omega_t - \sum_{i \in n^k} x_i^k = \sum_{c,t} m_{ct} \omega_t - \sum_{i \in m} x_i.$$

Define $y = y^k$, then by (TAP) $(\sum_{i \in m} x_i - \sum_{c,t} m_{ct}\omega_t), y, m) \in P$. Thus the allocation (x, y) is feasible for the jurisdiction m, and condition (3) of the definition of Pareto equivalence is satisfied. By assumption, the two jurisdictions have the same crowding profiles, and so condition (2) is satisfied as well. Finally, we must show that for all $\hat{i} \in m$ such that in the core state $\hat{i} \in n^{\tilde{k}} \in n$, it is the case that $(x_{\hat{i}}, y, m) \succeq_t (x_{\hat{i}}^{\tilde{k}}, y^{\tilde{k}}, n^{\tilde{k}})$, where $\theta(\hat{i}) = (c, t)$ for some $c \in \mathcal{C}$. This is almost immediate. By hypothesis, (X, Y, n) is a core state and so there is an individual $i \in n^k$ such that $\theta(i) = (c, t)$, and $(x_i^k, y^k, n^k) \sim_t (x_{\hat{i}}^{\tilde{k}}, y^{\tilde{k}}, n^{\tilde{k}})$. But by construction, $(x_{\hat{i}}, y) = (x_i, y^k)$. Thus, by (TAC),

$$(x_{\hat{i}}, y, m) \sim_t (x_{\hat{i}}^{\tilde{k}}, y^{\tilde{k}}, n^{\tilde{k}}),$$

and we conclude that condition (3) holds.

■

We conclude that when SGE is satisfied, agents can do no better in taste-heterogeneous jurisdictions than in weakly taste-homogeneous jurisdictions. Note that is a generalization of the homogeneity results we currently have for anonymous crowding models. In this case, there is only one crowding type, and so weak taste-homogeneity implies that agents can do no better than in completely taste-homogeneous jurisdictions in any core state.

4. Hedonic Prices and the Crowding Types Model

It would be interesting to show that the characteristics of agents (tastes and crowding types) have values which are independent of each other. If true this were, we should be able to find "prices" for agents' characteristics such that core utility level of each agent can be found by summing up the prices of the characteristics he brings to the market.

The idea of hedonic decomposition of various attributes of commodities goes back at least as far as Lancaster (1966) and Rosen (1974). It has been restated more recently in the context of characteristic function games by Engl and Scotchmer (1993) and Wooders (1992).[10] These papers present models of abstract economies in which agents are described by a list of characteristics that include tastes, endowments, crowding types and possibly other attributes as well. There is at least a superficial similarity between the models of economies in which agents are valued according to their characteristics, and the crowding types model presented in the current paper. It is perhaps surprising, therefore, that the value of agent characteristics are *not* necessarily independent in the crowding types model even when small groups are effective. Consider example two, above. There are four attributes possible, two taste patterns and two crowding types. Let P_x be the market price of attribute x. Then we have four equations and four unknowns of the following form:

$$P_C + P_W = 85$$

$$P_C + P_B = 75$$

$$P_M + P_W = 75$$

$$P_M + P_B = 85.$$

[10] These models are identical to models of pregames, cf, Wooders (1979, 1994) and references therein, when the players are attributes, or bundles of attributes ("syndicates" in the terminology of Wooders and Zame (1987)).

In words, a carpenter who likes wooden fences receives 85 in the core, and so his attribute wages must sum up to this number, for example. Subtracting the second from the first equation and the fourth from the third equation gives the following:

$$P_W - P_B = 10$$

$$P_W - P_B = -10.$$

Since no set of values can satisfy both of these equations, decentralizing prices do not exist in this case. This means that in general independence fails. The reason is that there is a bonus for being an agent who likes the type of fence he is best at building.

This is a fairly intuitive result which we see reflected in everyday life. For example, the wages paid to various types of workers are not the same even in relative terms across the country. What drives this is the assumption that when an agent moves to a location, he brings his external effects with him. He cannot sell his skills, or transfer his negative external effects outside the jurisdiction in which he resides. For example, when a doctor chooses a place to live, he does so knowing that he will have to find a job in the same location. A doctor is perfectly willing to accept a lower wage if the value of the public goods and amenities offered in a jurisdiction are sufficient, given his tastes, to compensate for the loss. This limitation on the market for crowding characteristics, which is fundamental to local public goods economies, prevents the prices of characteristics from equalizing across jurisdictions in general. If this restriction were discarded, as it is for private goods, prices of characteristics would equilibrate.[11]

[11] Note that this conflicts with the major conclusion of Engl and Scotchmer (1993). One immediate implication is that the models of Wooders (1992) and Engl and Scotchmer (1993) is not formally related to the crowding types model presented in Conley and Wooders (1994a).

5. Conclusion

In conclusion, we showed in Conley and Wooders (1994a) that when small groups are effective in a local public goods economy with crowding types, the core can be decentralized with anonymous prices. That is, for every core state there is a corresponding equilibrium state supported by prices that do not depend of the tastes of an agent or any other private information. This is analogous to results for private goods economies and local public goods economies with anonymous crowding, but in marked contrast the result for public goods economies and local public goods economies with differentiated crowding.

In this paper we continue this research program by investigating the homogeneity properties of optimal jurisdictions in local public goods economies with crowding types. Our purpose when we began this research was to generalize the result that there is never an advantage to mixing agents with different tastes in same jurisdiction from the anonymous crowding case to the crowding types case. We found, however, that the result does not carry over. This is surprising since it possible in the crowding types model to enjoy the full array of crowding characteristics without being forced to put agents with different tastes together. We demonstrate that taste-homogeneity fails regardless of whether crowding takes place in consumption or production. On the other hand we were able to prove that there is no reason to mix agents of different taste types *within a given taste type* in optimal jurisdictions. We note that this result implies the taste homogeneity results we already have for the anonymous crowding case.

There are many possible directions for future research. We have shown a negative result in general, but whether reasonable restrictions on the economic domain would allow a strong taste-homogeneity result to be recovered remains an open and interesting question. We speculate that, if the values of characteristics were independent in the sense of section four, strong taste-homogeneity would obtain. It is not clear to us what economic assumptions, however, would imply independence. The questions of existence of equilibrium, and convergence of the epsilon core to the epsilon equilibrium are also open.

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