Comparative urban institutions and intertemporal externality: a revisit of the Coase conjecture

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(ABSTRACT)

Coase originally formulated his conjecture about intertemporal price competition in the context of a land market, but it has been applied almost exclusively to non-spatial markets. This paper revisits the Coase Conjecture in the context of land development and urban institutions. I compare four institutional arrangements based on the combination of land tenure options and local governance forms: *private/rental*, *public/rental*, *private/owner* and *public/owner*. The two-period model developed in this paper shows that homeownership may result in more land development than leasehold. Numeric examples suggest (1) *public/owner*, i.e., the common form of government providing collective goods, may be efficient for more uniform distribution of consumer; (2) rentals can be desirable for "poor" communities; (3) *private/owner*, such as CID (Common Interest Development) and condominium, is more efficient for "rich" communities; (4) restrictive zoning reduces social surplus, and "rich" community may adopt more restrictive measures. These results may help explain why public institutions are dominant in urban setting and why most private communities are small and located in the suburbs.

KEYWORDS: monopoly, durability, bundling, land, local collective good, public good, private community, urban institutions

JEL: D23, D42, H41, L12, R52

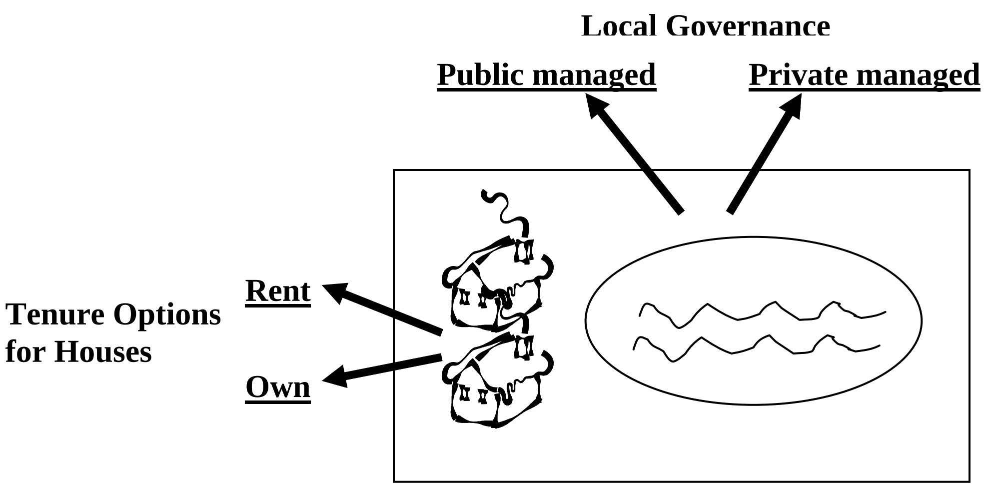
INTRODUCTION

When Coase (1972) introduced his famous conjecture on the relationship between monopoly and durability, he used land as the example and assumed a monopolist who owns all land in America. However, in the subsequent literature in industrial organization land has almost completely disappeared. Given the strong interest in the privatization of local public services and the growth of private communities, this paper revisits the Coase Conjecture from a land economic and institutional perspective. The goal is to formally analyze intertemporal behavior in land development and explore the relationship between land market structure and urban institutions.

The Coase conjecture is about a monopolist who may price discriminate over time. Since he does not internalize the impact of his behavior on the price of the goods sold in the past, he tends to lower the price in the following period(s). However, by rationally expecting the monopolist to behave in this way, customers would hold their purchases now and wait until the next period(s), thus resulting in the disappearance of the monopoly power "within a twinkling of eyes" (Coase 1972:143). The Coase conjecture is also called intertemporal externality or time inconsistency problem in the literature.

One reason that Coase' original example of land monopoly is no longer the main setting for the subsequent literature may be that land is a more complex good than standard industrial output. Foldvary (1994) provided a clear analysis of "territorial collective good", a concept that indicates that land and local collective goods are bundled together. Not only is their consumption but their transactions are also bundled together (Deng 2002). The bundling of transactions is important because it rules out "home bundling;" consumers cannot buy land and collective good separately and then consume them together at home. Therefore, we have to consider the demand and supply of land and collective good in a bundle. Nevertheless, the provision of land and collective good can be separate, giving rise to many important institutional issues in urban land use. Although this unique feature of land complicates the modeling effort, it provides an important link between the Coase conjecture and urban institutions.

The following example illustrates the institutional issues that arise from the combination of land tenure options and local governance structures. Let's suppose that some houses (the private goods) are surrounding a lake (the collective good). The houses are designated either owner-occupied or rented from the monopolist, who is also the developer, while the lake is designated public (government) managed or managed by the same private monopolist. The management of the lake for water quality, recreation and safety is the quality of the collective good, Q. Then the research question becomes: what is the best combination of land tenure options and local governance forms?



The above combinations make up the four categories of urban institutions we study.

Private/rental: private monopoly over both collective good and the rental of land/housing.

Public/rental: local government provision of collective good and rental of land/housing from a private monopolist. ***Private/owner***: private monopoly over collective good and individual ownership of land/housing. ***Public/owner***: local government provision of collective good and individual ownership of land/housing.[1] As a special case, I also introduce restrictive zoning in the scenario of *public/owner*.

[Table 1 around here.]

Monopoly is an important model in urban land use.[2] Although pure land monopoly may not be common or realistic, monopolistic power of varying degrees is common and monopoly is also a more tractable model than oligopoly. Fischel (1984) carefully summarized several reasons for analyzing monopolistic power in land use.[3] More importantly, he pointed out another setting in which a monopolistic model is very helpful: the community, instead of individual landowner or resident, may have some monopolistic power over land supply. A typical example is zoning and various planning tools. Many scholars have decried the deprivation of landowners' development rights by local zoning or planning regulations. In that case, local government has become the *de facto* (monopolistic) landowner who determines land supply.

Another reason for a monopoly model in the study of private community is basically proof by contradiction. Since some are arguing for privatization at higher level government, an inevitable question is what would happen with large-scale private institutions (such as at the scale of city or county). A hypothetically large-scale private institution would certainly be a land monopolist. By assuming a land monopoly model, we can investigate the consequences of a

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[1] I'm very grateful for the suggestions from an anonymous referee on the titles of the four institutional categories and how to illustrate them.

[2] Although the model starts with land monopoly, after development the world becomes more competitive. The latter may be what we observe in the real world. This is the essence of intertemporal price competition.

[3] Land monopoly is due to "the demand for housing sites that is inelastic. The source of this inelasticity is the comparative advantage that the entire metropolitan area (or other housing markets) has relative to the rest of the world. … another kind of monopoly may exist even when there are numerous communities. There may be a shortage of certain kinds of communities because it is difficult for developers to form new ones or for existing towns to modify their services to imitate the ones for which there is excess demand." (Fischel 1984: 142)

possible private institution at large spatial scale. If the result is negative, then it is "proved" that private institutions may not be desirable at large scales. This is also the essence of comparative institutional study because we can only observe one institutional arrangement in a particular setting of the real world.

In the growing literature on private communities, many questions remain open. First, why has there been widespread growth of private communities, especially in the suburbs (Barton & Silverman 1994; Gordon and Richardson 2001)? Many have addressed the issue from different perspectives (Foldvary 1994; Blakely and Snyder 1999; Helsley and Strange 1998; Webster 2001; Deng 2003a). The present paper will add to this literature by explaining in particular why private communities are located mainly in the suburbs.

A second question is why public institutions, rather than private developers, provide local public goods? There is no inherent reason why local water quality, for example, should be governed by local governments rather than a private developer.[4] Many studies in the Tiebout (1956) tradition have found that some entrepreneurial behavior has to be assumed for local governments.[5] Researches in this vein can help us understand the behavior of local urban institutions but couldn't explain their institutional forms.[6] The contribution of the present paper will be to explain the dominance of certain institutional forms in a particular setting.

Most contemporary studies on institutions and the firm only focus on the relationship among parties within a contract or organization (see, for example, Williamson 1985; Hart 1995), while those on property rights (Barzel 1989) are largely limited to a static treatment. It remains

[4] In a penetrating study, Fischel (2001) analyzed the efficiency of American local government by comparing corporate voting and political voting.

[5] See Helsley (2003) for a good review on the studies related to local political institutions.

[6] Recent important studies on local government and private communities (see Helsley and Strange 1998, 2000; Henderson and Thisse 2001) are largely in the vein of Tiebout model by focusing on the strategic interaction between private community and the public sector.

an interesting research question how market structure and time dimension can be introduced into institutional studies, especially in the urban setting.

There has accumulated a large body of literature on intertemporal externality in the economics of industrial organization.[7] Bulow (1982) constructed a simple two-period model to analyze the problem faced by a durable-goods monopolist and how leasing can avoid it. The rational expectations equilibrium model in Stokey (1981) illustrates that as the length of the trading period approaches zero, the monopoly will eventually produce the competitive stock, following what Coase conjectured. Many studies analyze the same problem with some different assumptions and settings. Bond and Samuelson (1984) showed that depreciation and replacement sales reduce the monopolist's tendency to cut price. Reducing the durability of the output can also help the monopolist to avoid the time-inconsistency problem (Bulow 1986). The choice of technology can also become an endogenous variable for the monopolist (Karp and Perloff 1996; Kutsoati and Zabojnik 2001). Some recent papers (Waldman 1996; Fudenberg and Tirole 1998) focus on technology upgrade and the interaction between the prices of new and used products.

The model setup in this paper is built on Fudenberg and Tirole (1998) that provides a general treatment of the time inconsistency problem. In this paper several features of the model reflect the uniqueness of land and the link to urban institutions. First, I explicitly introduce a quality variable that stands for the collective good tied to land and, hence, is affected by how the collective good is provided—separately or bundled together. This is distinct from industrial products and makes the model a spatial model although it does not include traditional spatial variable such as distance.

[7] See Waldman (2003) for a good review of related literature.

Second, in the case of separate provision of land and collective good, I assume a median voter model for the government provision of collective good. However, the treatment in the model is more general given the separability of consumer type and collective good quality in the utility function. In other words, as long as the separability assumption holds, the result applies to any public decision-making model that only considers existing residents.

Third, the collective good is not assumed to be durable and it has to be provided in each period. I also assume its provision has to cover all existing residents no matter they purchased land in the past or in the current period. Therefore, in addition to the intertemporal externality, there is also a typical "public good" externality. If the monopolist is responsible for providing collective good, he cannot exclude existing residents who bought his land in the past from consuming the collective good. In the case of public provision, the monopolist determines the scale of collective goods provision by selling or renting land while not being responsible for their provision. This free riding behavior of the land monopolist is certainly another source of externality.

Following what Coase conjectured "in the twinkling of an eye", the model shows that, due to intertemporal externality, sales will result in more land development than rentals. If only rental is possible, i.e., in the absence of intertemporal externality, separate provision (*public/rental*) will lead to more land development. A numerical example based on uniform distribution of consumers suggests that *public/owner* may be more efficient at large spatial scales. This may help explain the dominance of public institutions at large spatial scales and why private communities are relatively small. The introduction of restrictive zoning is shown to be socially undesirable. In the scenario of a "poor" community, rental arrangements become more attractive. In contrast, *private/owner* arrangement, such as CIDs and condominiums, yields higher total social surplus in a "rich" community. Highly restrictive zoning may also be efficient for these affluent communities if local government provides the collective good. Overall, results from the numerical examples help to explain why public institutions prevail in cities and why most private communities are small, located in the suburbs, and for middle-upper classes.[8]

The remainder of the paper is organized as follows. In the first section, the basic setup for the model is introduced and the two benchmark cases of rental are discussed. The third section constructs two-period models for *private/owner* and *public/owner*, respectively. Then numerical examples based on different assumptions of consumer distribution are provided to illustrate the efficiency of different institutional arrangements in different scenarios. The last section discusses the findings and raises issues for future research.

THE MODEL

A land monopolist is assumed to own the land that is demanded by a group of consumers. The transaction and consumption of land and a collective good are always bundled together. This is a fact for territorial collective good. The basic setup follows Fudenberg and Tirole (1998). There are two periods, $t = 1, 2$, and the discount factor for both the consumers and the land monopolist is δ. This world ends at the end of the second period. On the demand side, a continuum of consumers are indexed by $\theta \in [0, 1]$, with a constant marginal utility of income. Per-period utility for a type-θ consumer is $\theta \cdot V(Q) + I$, where I is net income and Q denotes the quality of the bundle good—the provision of local collective good. $\theta \cdot V$ is then equal to consumer's valuation or willingness to pay (WTP) for the bundle good. Since the land is

[8] No doubt that the forces in Tiebout Hypothesis are fundamental in the shaping of these different communities. But, Tiebout Hypothesis itself cannot explain their different institutional forms, especially regarding intertemporal externality.

assumed to be infinitely durable and physically homogeneous, only the collective good may cause different qualities over time.

The distribution of consumer types on [0, 1] is given by cumulative distribution function $F(\cdot)$ with continuous density. Following Fudenberg and Tirole (1998), it is assumed that the hazard rate $h(\theta) = f(\theta) / (1 - F(\theta))$ is non-decreasing.[9] Hence, given an existing stock of x_1 of the bundle goods, potential or remaining consumers in the market for a price of $\theta \cdot V$ are those indexed by [θ, 1] and their number is $1 - F(\theta) - x_1$. Also, quality Q is assumed to contribute positively to consumers' utility or WTP, i.e., $V'(Q) \geq 0$.

On the supply side, the most important and obvious assumption is that land is bundled with a local collective good. Although their provision can be from different sources, their transactions and consumption are simultaneous. In the case of *private/owner*, both goods are provided by the monopolist whose objective is profit maximization. Although homeowners association decides on the provision of collective good once the private community has been established, in the development stage it is the developer/monopolist who makes the decisions on the development scale and the provision of collective goods. Barzel and Sass (1990) found empirical evidence that developers tend to provide in advance those public facilities and services that could later become a difficult decision for the homeowners. For those on which the homeowners could easily reach consensus or majority opinion, developers are likely to leave them to the homeowners association. Even in large development project of several stages, it is common practice for the developers to control the homeowners association by retaining a majority voting rights. Since our interest is in the development rather than the management of private communities, it is reasonable to assume the monopolist maximizing profit when providing both goods in a bundle.

[9] This assumption guarantees concavity of objective function. It also holds for any truncated demand function.

In the case of *public/owner*, we assume some collective decision making model (such as a median voter model) for the provision of collective good while the supply of land is still determined by the land monopolist's objective of profit maximization. Because land is infinitely durable, it is assumed that there is no cost of supplying land.[10] The cost of supplying the collective good is assumed to be constant relative to spatial scale (constant return to scale) but change with Q, the quality variable.[11] Denote unit cost as $C(Q)$ and assume $C'(Q) \geq 0$. In other words, the better is the collective good, the higher is the cost to provide it.

When local government provides the collective good, a possible scenario is that the local government will use zoning or planning, which is traditionally based on police power, to restrict development.[12] With restrictive zoning or planning, the development right of landowners is effectively held by local government. As the *de facto* owner of land development rights, local government intends to use zoning to maximize the property values of existing residents whose votes determine local offices.[13] With regard to providing collective good, local government maximizes the utilities of existing residents. Given our assumption of land monopoly that effectively rules out inter-governmental competition, these two objectives of local government don't necessarily need to be linked.[14]

The time line for the model is in the following sequence:

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[10] It is also assumed that development cost, if any, is zero. A positive development cost will not change the basic results.

[11] In general, returns to scale in municipal services "often exhibit roughly constant returns to scale" (Wheaton & Dipasquale 1996:334). This assumption also allows us to assume away the economy of scale without affecting basic results and focus only on collective good.

[12] Of course, it's also possible that the developer may have stronger influence on local government, which in turn becomes pro-development. This may be especially true for higher-level government, where special interest politics is stronger, or rural area where people are more concerned about economic development opportunities.

[13] This is in the same spirit as Brueckner (1983).

[14] As Fischel (2001) pointed out, with inter-governmental competition in a Tieboutian setting, the local government's finance department and planning development have to be considered together. In our model, the absence of rent capitalization means these two functions of local government can be separate.

First Period:	1	First-period land development (by the monopolist)
	2	*q1* residents move in
	3	Providing first-period collective good
	4	*(Restrictive zoning is imposed on land development)*
Second Period:	5	Second-period development
	6	*q2* residents move in
	7	Providing second-period collective good
	8	End of the world

Since the literature on durable goods usually treats the rental case as the benchmark in which the time inconsistency problem can be avoided, I also present two benchmark cases of rental. In the first case (*public/rental*), consumers rent land from the monopolist while some public entity (local government) determines how to provide the collective good. In the second benchmark case of *private/rental*, both land and collective good are provided by the monopolist.

Benchmark Case 1: *public/rental*

With separate provision of land and collective good, the quality of the bundle is exogenous to the monopolist's profit maximization problem. Given Q_1 and Q_2 in the two periods, the rental demand for the bundle goods at a rental price r is equal to $1-F(\theta)$, where

$$\theta \cdot V = r \tag{1}$$

Then the optimization problem for the monopolist is to rent land to consumers with types above θ^* so that his profit can be maximized.

$$\text{Max. } \left[1-F(\theta)\right] \cdot \theta \cdot V$$

It is obvious that θ^* is independent of V. Therefore, in Period 1, the monopolist rents $1 - F(\theta^*)$ of Q_1 quality land at a rental price of $\theta^* V(Q_1)$; in Period 2, he rents the same amount of land to the same people at a price of $\theta^* V(Q_2)$. From the first order condition we can have

$$\theta^* = \frac{1-F(\theta^*)}{f(\theta^*)} = \frac{1}{HazardRate} \quad (2)$$

Because $\frac{1}{\theta h}$ is the inverse elasticity of demand, this equilibrium condition says that it has to be equal to one when the monopolist maximizes his profit. This is a standard result for a single-product monopolist when the relative "markup" —the ratio between profit margin and the price, which is also called the Lerner index—is equal to one given the assumption of no cost in supplying land. The intuition behind this condition is that the monopolistic price distortion from the marginal cost has to be balanced against the decline of consumers' demand.

Since potential or future consumers haven't rented land and are not living in this place, they are not included in the existing residents who determine the median voter. Given the separability of θ and V in consumer's utility, as specified in (1), all consumers' utilities change proportionately with *V(Q)*. In this sense, maximizing the utility of the median voter, mean voter, or all voters does not make much difference to the result. The maximization problem for the government can be written as the following

$$\text{Max. } \int_{\theta^*}^{1} f(\theta)\theta V(Q)d\theta - \left[1-F(\theta^*)\right]\cdot C(Q)$$

The first order condition with respect to Q then becomes

$$\bar{\theta}^* V'(Q) = \left[1-F(\theta^*)\right]C'(Q) \quad (3)$$

Here I slightly abuse the notation and use $\bar{\theta}^*$ to denote the mean of θ on [θ^*, *1*]. This condition means that the consumers' marginal valuation from higher quality of collective good should be equal to the marginal cost of providing the collective good. It also suggests that the provision of collective good is stable over time in the case of *public/rental*, with the same quality Q in each period.

Benchmark Case 2: *private/rental*

With bundled provision, the monopolist provides both land and the collective good in a bundle and rents them to the consumers. He now faces the following maximization problem:

$$\text{Max.}\ \left[1-F(\theta)\right]\cdot\theta V(Q)-\left[1-F(\theta)\right]\cdot C(Q)$$

The first order condition then becomes

$$\text{Hazard rate} = \frac{f(\theta^*)}{1-F(\theta^*)}=\frac{1}{\theta^*\left(1-\dfrac{C}{V\theta^*}\right)} \tag{4}$$

$$\theta^* = \frac{C'(Q)}{V'(Q)} \tag{5}$$

The second condition (5) means that when maximizing the profit to the monopolist, the marginal rent ($\theta^* V'$) should be equal to the marginal cost (C') with regard to the collective good provision. The first condition (4) looks similar to (2) but with an extra factor, which leads to the following proposition.

Proposition 1: when only rental is possible, what the land monopolist rents in the case of private provision of land and collective good is less than or equal to that in the case of public provision.

The fundamental reason behind Proposition 1 is the externality in providing the collective good. With public provision of land and collective good, the monopolist can free-ride on the provision of collective good and doesn't need to worry about the cost. In contrast, when he is responsible for providing both land and collective good, he has to take into account the cost of providing the collective good. In the rental case intertemporal externality doesn't exist.

Proposition 2: when only rental is possible, at equilibrium the first-order derivative of the ratio of cost vis-à-vis WTP (C/V) should be positive or equal to zero while the marginal cost has to be less than or equal to the marginal valuation.

This proposition says that, on the one hand, in order to achieve equilibrium, the cost must increase faster than the consumer's WTP. Otherwise, the land monopolist will be motivated to provide even higher quality of the bundle good—better provision of the collective good, possibly towards infinite if no boundary condition exists. Hence, equilibrium requires that the ratio of cost vis-à-vis WTP has to increase with quality of the bundle good. On the other hand, the marginal cost has to be no greater than the marginal increase of WTP. This ensures the monopolist's profit is maximized.

In order to look at how bundling its provision with land affects the collective good, we can compare (3) and (5), the first-order conditions for the two benchmark cases. If we assume both cases have the same group of consumers renting the land, i.e., the same θ, then by the definition of θ we can have $\frac{\bar{\theta}}{(1-F)} > \bar{\theta} > \theta$. It is then easy to see that public provision, in which case the equilibrium requires the condition (3), has a higher $\frac{C'}{V'}$. This means that, *ceteris paribus*, public provision can tolerate a relatively higher marginal cost in providing the collective good than private provision. This is not surprising given the free-riding behavior of the land monopolist.

TWO-PERIOD MODEL OF SALE

In many cases, leasing may be inefficient, impossible, or prohibited by the law and sale/purchase becomes the only or best option for the monopolist/consumers. Although leasing can avoid the time consistency problem, many discussions in the literature of industrial organization have pointed out the problems of leasing (See, for example, Tirole 1988). In urban land use, MacCallum (1970) has been advocating for the leasehold-based proprietary communities. Deng (2002) argues that the leasehold-based system combines the efficiency properties of Tieboutian (1956) competition and George's (1879) insight on rent capitalization. These arguments are all based on the assumption of a competitive market. If monopoly instead of a competitive market exists in the land market, then what is the impact of intertemporal externality?

In order to model the time inconsistency problem, I assume the monopolist cannot make any commitment or guarantee in terms of future sales or prices. This may be more realistic for land use than for ordinary durable good because monopoly in land use is usually based on horizontal differentiation that might make pricing more difficult. An "anonymous" and frictionless second-hand market is also assumed to exist. Because the collective good is provided to all existing owners in the same period, it doesn't cause any quality difference between new and old buyers that is typical in software and some other products (see Waldman 2003 and others). Because the second-hand market is frictionless, a consumer's decision in the second period is not affected by whether or not he bought land in the first period. In other words, consumer doesn't need to choose among used good and new good; they are treated the same in the model.

Assuming the quantity of land sold in the first period is q_1 with quality Q_1, I first work on the second period and then backwards on the first period. Of course, consistent with the literature, a key assumption is that consumers can correctly or rationally anticipate the second-period price in the first period.

Private/owner

I first assume that land and the collective good are provided in a bundle by the monopolist, who intends to maximize the profit.

The second period. In the second period, assume consumer of type θ_2 is indifferent about whether to purchase land or remain outside the area. So, we have

$$P_2 = \theta_2 \cdot V(Q_2)$$

Consumers with θ above θ_2 are all current residents in this area in the second period, including both those who bought land in the second period and those who bought a total amount of q_1 in the first period. That is, $1 - F(\theta_2) = q_1 + q_2$. Hence,

$$q_2 = F(\theta_1) - F(\theta_2) \tag{6}$$

Now, the monopolist maximizes his second-period profit.

$$\text{Max. } \Pi_2 = p_2 q_2 - (q_1 + q_2) \cdot C(Q_2)$$

$$= \theta_2 V(Q_2)[F(\theta_1) - F(\theta_2)] - [1 - F(\theta_2)]C(Q_2) \tag{7}$$

The second term in the monopolist's profit function is due to the assumption that the provision of collective good has to cover not only new buyers but also all existing residents. This is based on the non-exclusivity assumption or the "public good" externality for the collective good within the territory. Then, the first order conditions become

$$\frac{\partial \Pi_2}{\partial \theta_2} = V(Q_2)[F(\theta_1) - F(\theta_2)] - \theta_2 V(Q_2) f(\theta_1) + C(Q_2) f(\theta_2) = 0 \tag{8}$$

$$\frac{\partial \Pi_2}{\partial Q_2} = \theta_2 V'(Q_2)[F(\theta_1) - F(\theta_2)] - C'(Q_2)[1 - F(\theta_2)] = 0 \tag{9}$$

Proposition 3: with private provision of land and the collective good, the monopolist has cumulatively sold more land up to the second period than he rents in the rental case.

This proposition states that, *ceteris paribus*, when land and the collective good are both provided in a bundle by the monopolist, the cumulative amount of land he sells up to the second period should be larger than the rental amount. Of course, the quantity of land the monopolist rents is the same in both two periods, given our discussion of the two benchmark cases. The reason for this result is that the existence of intertemporal externality allows the monopolist to expand the sales at the cost of the consumers who bought land in the first period.

Rearranging (9), we can have

$$\theta_2 = \frac{C'(Q_2)}{V'(Q_2)} \cdot \frac{q_1 + q_2}{q_2} \geq \frac{C'(Q_2)}{V'(Q_2)} \tag{10}$$

Because $\theta_2 \leq 1$ and it is also smaller than θ^* in the *private/rental* case, as shown by Proposition 3, comparing (10) and (5) shows that $\frac{C'(Q_2)}{V'(Q_2)}$ is now less than in the case of *private/rental* if the second-period sale quantity θ_2 is assumed to be the same. Depending on the first-order derivatives of the cost and WTP, the impact of sale versus rental on the provision of collective good can then be analyzed. For example, if the first order derivative of cost with regard to Q increases, i.e., cost increases faster and faster, and the first order derivative of WTP decreases with Q, then (10) implies that *private/owner* will result in lower quality of collective good given the same θ. Furthermore, since θ_2 (the LHS in Eq. 10) is even smaller than in the rental case, as Proposition 3 shows, then the quality Q will be even lower in this example and the effect on Q, as discussed above, will be even more significant.

The first period. We now work backward to the first period. As the rational expectation assumption implies, the land price in the first period should depend on their expectation of the second-period price. That is

$$p_1 = \theta_1 V(Q_1) + \delta\theta_2 V(Q_2) \tag{11}$$

So, the monopolist's first-period profit function is

$$\begin{aligned}\Pi_1 &= p_1 \cdot q_1 - q \cdot C(Q_1) \\ &= [1 - F(\theta_1)] \cdot [\theta_1 V(Q_1) + \delta\theta_2 V(Q_2) - C(Q_1)]\end{aligned} \tag{12}$$

Note the profit function subtracts the cost of providing the collective good because it is now bundled with land and enters the monopolist's calculation. We can also obtain the second-period profit function as in (7). The monopolist then maximizes his overall profit

$$\begin{aligned}\Pi &= \Pi_1 + \delta \cdot \Pi_2 \\ &= [1 - F(\theta_1)] \cdot [\theta_1 V(Q_1) + \delta\theta_2 V(Q_2) - C(Q_1)] + \delta\theta_2 V(Q_2)[F(\theta_1) - F(\theta_2)] - \delta C(Q_2)[1 - F(\theta_2)]\end{aligned} \tag{13}$$

The first-order condition for Q_1 can be obtained as follows. Note that Q_1 is independent of θ_2 and Q_2 given that the collective good is not durable and is always assumed to be provided to all residents within the area.

$$\theta_1 V'(Q_1) - C'(Q_1) = 0 \tag{14}$$

The first-order condition for θ_1 is quite complex involving the derivatives of θ_1 with regard to θ_2 and Q_2. In a simpler approach, we can directly use q_1, q_2 instead of θ_1, θ_2. Denote $x = q_1 = 1 - F(\theta_1)$, $y = q_1 + q_2 = 1 - F(\theta_2)$. Obviously, $\theta_2 = F^{-1}(1 - y)$. Also note that $\left(F^{-1}\right)' = \frac{1}{f}$, $\left(F^{-1}\right)'' = -\frac{f'}{f^3}$. Then, the first-order conditions for the monopolist's first-period profit maximization problem can be rewritten and the derivatives of Q_2, y with regard to x can be obtained.

$$\frac{\partial Q_2}{\partial x} = \frac{f^2 - f'(y-x)}{U'(Q_2)\cdot f^3} \tag{15}$$

$$\frac{\partial y}{\partial x} = \frac{W'(Q_2)\cdot y\left[f^2 - f'(y-x)\right] + U'(Q_2)\cdot f^2\left(y - x + f\cdot F^{-1}\right)}{f^3\cdot U'(Q_1)\left[F^{-1} - W(Q_2)\right]} \tag{16}$$

where $U(Q) = \dfrac{C(Q)}{V(Q)}$ and $W(Q) = \dfrac{C'(Q)}{V'(Q)}$.

To better understand the first-order conditions in (15) and (16), we can make some simplifying assumptions. If we assume $W'(Q_2) = 0$, i.e., the second-order effects of $C(Q_2)$ and $V(Q_2)$ are negligible, then from (16) we have

$$\frac{\partial y}{\partial x} = \frac{\theta_1 V'}{\theta_2 V' - C'} \tag{17}$$

So, given the linear assumption for the cost and valuation functions, if the marginal valuation ($\theta_2 V'$) is higher than the marginal cost (C'), then $\frac{\partial y}{\partial x} > 0$. In other words, if the marginal price with regard to better second-period quality is larger than the marginal cost at equilibrium, then the standard result in durable goods literature still holds—total sale size will increase with the first-period sale. This result is consistent with the profit maximization goal of the monopolist. However, if the second-period quality is such that marginal revenue is less than marginal cost, i.e., $\theta_2 V' - C' < 0$, then $\frac{\partial y}{\partial x} < 0$, which means that the monopolist may even reduce the sale of land in the second period.[15]

[15] It is possible that the monopolist may even want to buy back land in order to save on the cost of providing the collective good.

The meaning of (15) becomes clearer if we assume a uniform distribution function for the consumers. In that case, $f(\theta) = 1$, $F(\theta) = \theta$, $f'(\theta) = 0$, and (15) becomes $\frac{\partial Q_2}{\partial x} = \frac{1}{U'(Q_2)}$. So, if the ratio of cost vis-à-vis WTP increases with the quality of the bundle good, i.e., $U'(Q_2) > 0$, then $\frac{\partial Q_2}{\partial x} > 0$, meaning the quality of the collective good in the second period will increase with the quantity of sale in the first period. The more is sold in the first period, the better quality of collective good will the monopolist provide in the second period. Vice versa, if $U'(Q_2) < 0$, then $\frac{\partial Q_2}{\partial x} < 0$. In that case, the more land is sold in the first period, the worse quality of the collective good will the monopolist provide in the second period. In general, the tradeoff is that, on the one hand, higher quality leads to higher cost, especially given the externality in providing the collective good, and on the other hand, higher quality results in higher price that could reduce intertemporal competition faced by the monopolist.

Now, in the monopolist's second-period maximization problem, substitute (15) and (16) into the first order condition with regard to *x* (like Eq. 8 and 9 that are first order conditions with regard to θ) and we have

$$\theta_1 V(Q_1) - C(Q_1) - \frac{V(Q_1)}{h(\theta_1)} + \delta\left[\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)\right]\frac{\partial y}{\partial x} = 0 \qquad (18)$$

where $h(\cdot)$ is the hazard rate function. Equations (14) and (18) can solve for θ_1 and Q_1, given the relations between θ_2, Q_2 and θ_1 as specified in (15) and (16). Hence, the whole system is now mathematically solvable.

If we compare *private/owner* with *private/rental*, it is easy to see that the first-period quality is determined in the same way. But, the first-period quantities are determined very differently. *Private/owner* in the first period depends also on what happens in the second period due to intertemporal externality.

Proposition 4: the relationship between quality and quantity in the first period are the same in the private/owner and private/rental cases. If the second-order effects can be ignored and $\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)$ *has different signs from* $\theta_2 V'(Q_2) - C'(Q_2)$*, the first-period* θ_1 *in the sale case is larger (i.e., smaller* q_1*) than in the rental case.*

This proposition basically describes how the (expected) second-period condition affects the first period sale quantity, as compared to the rental case. $\theta_2 V' - C'$ is the marginal profit with regard to the quality. Rearranging $\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)$ shows that it is basically a comparison between the so-called relative "mark-up" $\frac{\theta_2 V - C}{\theta_2 V}$ and the inverse elasticity of demand $\frac{1}{\theta_2 h}$. Recall that in the *private/rental* case, these two should be equal in the first-order condition (4). So, Proposition 4 states that, *ceteris paribus*, if increasing second-period quality also increases profit and, hence, the aggregate development scale over the two periods increases with the first-period quantity, then whether or not second-period profit margin is less than what the monopolist charges in the rental case will determine if the monopolist will sell less quantity in the first period than he will rent. Profit margin being less than in the rental case is obviously good for the consumers, bad for the monopolist. Alternatively, if the aggregate development scale over the two periods decreases with the first-period quantity, then whether or not second-period profit margin is less than what the monopolist charges in the rental case will determine if the monopolist will sell more quantity in the first period than he will rent.

Public/owner

Now consider the case that the land and the collective good are provided separately. The monopolist still maximizes profit from selling land to the consumers, but the collective good is provided by a government or some public entity that maximizes the utility of the existing residents within the area.

The second period. The monopolist's second-period profit function is

$$\Pi_2 = \theta_2 V(Q_2)\left[F(\theta_1) - F(\theta_2)\right] \tag{19}$$

Obviously, he now doesn't need to care about the cost of providing the collective good. The first-order conditions for the monopolist's maximization problem are then

$$F(\theta_1) - F(\theta_2) - \theta_2 f(\theta_2) = 0 \tag{20}$$

The government's optimization problem is the same as in the rental case. In other words, first-order condition (3) holds here for the quality Q in both the first period and the second period.

The first period. Assume again that the consumers have correct or rational expectation in the first period and then Equation (11) still holds. The monopolist maximizes his overall profit

$$\begin{aligned}\Pi &= \Pi_1 + \delta\Pi_2 \\ &= \left[\theta_1 V(Q_1) + \delta\theta_2 V(Q_2)\right]\left[1 - F(\theta_1)\right] + \delta\theta_2 V(Q_2)\left[F(\theta_1) - F(\theta_2)\right]\end{aligned} \tag{21}$$

To simplify the solution, we still use x, y to replace θ_1 and θ_2, and then the first-order condition for the maximization problem in the second period, i.e., Eq. (20), becomes

$$F^{-1}(1-y)-\frac{y-x}{f(\theta_2)}=0 \tag{22}$$

Taking derivative with regard to x yields

$$\frac{\partial y}{\partial x}=\tfrac{1}{2}(y-x)\frac{f'}{f^2}+\tfrac{1}{2} \tag{23}$$

Because of the assumption of monotone hazard rate, $f'>0$. Hence, (23) implies $\frac{\partial y}{\partial x}>0$, which is consistent with the standard result in the durable goods literature.

The first order condition for the first period maximization problem is now

$$\theta_1 V(Q_1)-\frac{V(Q_1)}{h(\theta_1)}+\delta\left[\theta_2-\frac{1}{f(\theta_2)}\right]\cdot V(Q_2)\frac{\partial y}{\partial x}=0 \tag{24}$$

Now the system that consists of (3) (for both Q_1 and Q_2), (22), (23), and (24) is mathematically solvable. Although the first order relationship between Q and θ in the *public/owner* case is the same as in the rental case, as specified in (3), the change of the aggregate sale quantity y (or the decrease of θ in the second period) means the provision of the collective good will also change.

Proposition 5: in the case of public/owner, if there is no negative sale (buy-back) in the second period, the change of quality from the first period to the second period depends on how $\frac{C'(Q)}{V'(Q)}$ decreases. If marginal cost increases faster than marginal WTP with regard to Q, then quality declines in the second period; if marginal cost increases slower than WTP, then quality rises in the second period.

Because the collective good is now provided by the government, its provision is affected by current population that in turn depends on the cumulative quantity of land sold. If we assume that, in net, the monopolist doesn't buy back land in the second period, the cumulative land quantity increases over time. Hence, median voter's valuation of the bundle good decreases with growing population. $\frac{C'(Q)}{V'(Q)}$ measures the marginal cost vis-à-vis marginal utility. Equilibrium condition requires it also declines from the first period to the second period. So, Proposition 5 basically states that if cost increases faster than utility, the second-period government will opt for lower quality of the collective good; otherwise, the quality will rise.

Public/owner **with Restrictive Zoning/Planning**

Now we consider a special and more realistic case of separate provision. In the beginning of the first period, land development is still determined by the monopolist. After the first-period purchasers become residents, they form (or dominate) local government and implement zoning or planning regulations that are designed to maximize the property values of first-period residents. So, in the second period, land development is determined by the restrictiveness of zoning.

The second period. Zoning or planning is now in place and local government is dominated by existing (first-period) residents. With regard to zoning control that determines land development, local government maximizes the property value of existing (first-period) residents.

$$\text{Max.} \quad p_2 q_1 = \theta_2 V(Q_2)\left[1 - F(\theta_1)\right]$$

This yields the corner solution of $\theta_2 = \theta_1$, which means there will be no development in the second period at all. More realistically, the community usually allows some development. Suppose the restrictiveness of zoning can be represented by β, which satisfies

$$y = \beta x \tag{25}$$

β is in the range of $[1, 1/x]$. When β equals one, there is no development in the second period. The higher is β, the less restrictive is zoning or planning. Obviously, β reflects factors such as special interest politics, public policy or legal environment, and so on.

The now "passive" monopolist's profit function is still the same as in (19). With regard to providing the collective good of Q_2, local government maximizes all residents' utility. The first-order condition is the same as (3).

The first period. Consumer's rational expectation yields the same pricing equation as in (11). With regard to providing the collective good, local government maximizes the residents' utility. Since there are no residents in the beginning, the land monopolist determines the development scale by maximizing the total profit over the two periods. The maximization problem is the same as in (21) and yields the same first-order condition as (24).

Substituting (25) into the first-order condition of (24) yields

$$\theta_1 V(Q_1) - {V(Q_1)}\big/{h(\theta_1)} + \delta\left[\theta_2 - {1}\big/{f(\theta_2)}\right]\beta V(Q_2) = 0 \tag{26}$$

The system of equations (3) (for Q_1 and Q_2, respectively), (25) and (26) is now mathematically solvable. Applying (3) to both periods yields

$$\frac{\bar{\theta}_2}{\bar{\theta}_1} = \beta \frac{C'(Q_2)}{V'(Q_2)} \Big/ \frac{C'(Q_1)}{V'(Q_1)} \tag{27}$$

This equation tells us how the quality of collective good changes with the restrictiveness of zoning or planning. In the case of uniform distribution, $\frac{\bar{\theta}_2}{\bar{\theta}_1} = \beta$, then $\frac{C'(Q_2)}{V'(Q_2)} = \frac{C'(Q_1)}{V'(Q_1)}$. If C'/V' is a monotone function, then Q_1 equals Q_2. C'/V' is a relative measure of how (marginally) costly is the provision of collective good. If $\frac{\bar{\theta}_2}{\bar{\theta}_1} < \beta$, then $\frac{C'(Q_2)}{V'(Q_2)} < \frac{C'(Q_1)}{V'(Q_1)}$, meaning that Q_2 will be such that it is relatively less costly to provide the collective good in the second period. Alternatively, if $\frac{\bar{\theta}_2}{\bar{\theta}_1} > \beta$, then $\frac{C'(Q_2)}{V'(Q_2)} > \frac{C'(Q_1)}{V'(Q_1)}$, meaning that Q_2 will make the provision of collective good in the second period relatively more costly.

The intuition is that, in the presence of restrictive zoning, a distribution that is skewed towards high-end consumers results in a quality of collective good that is relatively more cost-benefit effective in the second period. Since restrictive zoning effectively controls intertemporal externality, high-end consumers will be more concerned about the cost of providing the collective good in the second period. In contrast, for a distribution that is skewed towards low-end consumers, the impact of restrictive zoning on intertemporal externality is limited, resulting in pursuing higher quality collective good that may not be so cost-benefit effective but can help mitigate intertemporal competition.

MOST EFFICIENT INSTITUTIONS AND NUMERICAL EXAMPLES

To analyze which institutional setting is best for either the society or the monopolist, we can calculate total social surplus and monopoly profit in each case and then compare them. The institutional arrangement that yields the highest social surplus is most efficient from a social perspective. Because the quantity and quality of the bundle goods sold in each period are all interdependent and all results depend on consumer distribution, it is difficult to obtain closed form solutions without specifying the functional forms. Numerical methods are used in this section to provide examples that illustrate how different distributions of consumers affect the most efficient form of institutions.

If we assume "social" discount rate is the same as the one used in the rational expectation of price, then we have the following formula to calculate total social surplus:[16]

$$S = \bar{\theta}_1 V(Q_1) - [1 - F(\theta_1)] \cdot C(Q_1) + \delta \bar{\theta}_2 V(Q_2) - \delta [1 - F(\theta_2)] \cdot C(Q_2) \tag{28}$$

where $\bar{\theta}_1 = \int_{\theta_1}^{1} \theta f(\theta) d\theta$ and $\bar{\theta}_2 = \int_{\theta_2}^{1} \theta f(\theta) d\theta$. This definition basically aggregates all current residents' utility minus the cost of providing the collective good in each period and then adds the discounted second-period value to the first period one.

For simplicity, the discount rate is assumed to be one, i.e., no discount. We also assume the following functions for the cost of providing the collective good and the consumers' valuation (or WTP).

$$C(Q) = Q^2$$

$$V(Q) = 2 + 2Q$$

Given the importance of consumer distribution to the model, three different distribution functions are assumed for the following three numerical examples, respectively (Figure 1). For the first numerical example, a uniform distribution of consumers is assumed on [0, 1]. Then, $F(\theta) = \theta$, $f(\theta) = 1$, $f'(\theta) = 0$, $\bar{\theta} = \int_{\theta}^{1} \theta f(\theta) d\theta = \frac{1}{2}\left(1 - \theta^2\right)$. In the second example, the density function is assumed to be linearly decreasing to zero when θ equals one. $F(\theta) = 2\theta - \theta^2$,

[16] In the previous cases of separate provision, I assume a myopic government who only cares about existing residents in the current period. This assumption is obviously different from maximizing total social surplus as in (28).

$f(\theta) = 2 - 2\theta$, $f'(\theta) = -2$, $\bar{\theta} == \frac{1}{3} + \left(\frac{2}{3}\theta^3 - \theta^2 \right)$. This is like the case of a "poor" community where consumers are concentrated in lower end of WTP distribution. The third example is the opposite, a "rich" community, where consumers are concentrated in the upper end of the distribution. The density function is a linear increasing function of θ that starts from zero when θ equals zero. $f(\theta) = 2\theta$, $F(\theta) = \theta^2$, $f'(\theta) = 2$, $\bar{\theta} = \frac{2}{3}\theta^3$.

[Figure 1 around here]

With these specifications of the functional forms, we can then solve the problems in different institutional settings either directly or by using numeric methods. Table 1 lists the results for the three examples, each of which include five different institutional arrangements. For *public/owner* with zoning, we find the solutions for a range of possible restrictiveness of zoning. Table 2 includes the maximum and minimum values of social surplus and monopolistic profit within the possible range of restrictive zoning.

[Table 2 around here]

There are some general results that largely hold for all three examples. First, the two rental cases have the same land quantity and quality in the two periods. This is expected because rental can effectively avoid the time inconsistency problem. Second, *private/rental* (proprietary community) generally results in more development than *public/rental* due to the public good externality. In the cases of uniform distribution and "poor" community, *private/rental* has lower quality of collective good than *public/rental*. But, in the case of "rich" community, *private/rental* yields higher quality of public goods. Third, with *public/owner*, more land is provided in the second period and the quality of collective good declines in the second period. This appears to fit into the common perception of real estate development, especially its impact on public goods and public services. But, with *private/owner* (like in CIDs), the size of land development actually decreases in the second period with a sharp increase in the quality of collective good. This result from the numerical examples implies that the monopolist actually buys back land while providing higher quality of collective good in the second period.

It is obvious from Table 1 that, in the example of uniform distribution, *public/owner* has the highest value of both profit and total social surplus. This result supports the common form of local government provision of collective goods in urban areas. On the one hand, sale or homeownership makes intertemporal price competition possible, which weakens the monopoly power and is therefore good for consumers. On the other hand, separate provision also deprives the monopolist of bundling as a way to weaken intertemporal competition. In a sense, this numerical example helps to explain why public institutions prevail at large spatial scales, where consumers are more evenly distributed, and why most private communities are relatively small-scale.

However, once restrictive zoning is available for local government to control the development, even the maximum value of social surplus drops below all other possible institutional arrangements. In contrast, the monopolist's profit rises further up. This strongly suggests that restrictive zoning, in its extreme form and in the scenario of uniform distribution of consumers, is socially inefficient and only benefits existing landowners.

Figure 2 shows how social surplus and profit changes with the restrictiveness of zoning. The more restrictive is zoning (the closer is beta to 1), the higher is social surplus and profit. In this case, since restrictive zoning and the development scale in the second period are exogenous, more restrictive zoning actually results in more development in the first period and, hence, higher social surplus. Nevertheless, all possible values of social surplus under restrictive zoning are still lower than in the other four institutional settings.

[Figure 2 around here]

In the "poor" community example, *public/owner* also dominates other institutional arrangements. However, two rental arrangements yield profit and social surplus that are close to *public/owner* and significantly higher than *private/owner*. Specifically, *public/rental* has almost the same value of social surplus as *public/owner*. The reason may be that the concentration of consumers at the lower end of the distribution reduces the difference between sale and rental in terms of total social surplus. The monopolist's profit in *private/rental* is also close to that of *public/owner*. All these results indicate the attractiveness of rental arrangements. *Private/rental* in company towns might be a case in point.

With restrictive zoning introduced in the case of *public/owner*, social surplus jumps up above all other four institutional arrangements while profit drops. In this extreme form of restrictive zoning, the monopolist will develop most of land in the first period by anticipating zoning constraint in the second period. This turns out to be good for poor people whose housing needs are satisfied.

Figure 3 shows that, in the case of "poor" community, possible range of restrictive zoning is very limited. Because all land is developed in the second period, social surplus changes little with zoning "restrictiveness". Profit increases when more development occurs in the second period.

[Figure 3 around here]

The "rich" community example in Table 1 shows that arrangements with bundled provision of land and collective goods can yield highest social surplus or profit. *Private/owner* has the highest social surplus even when restrictive zoning is introduced into *public/owner*. The concentration of "rich" consumers provides only limited opportunity for the monopolist to reduce intertemporal competition. By doing so, the monopolist has to significantly lower the price, increase the sales in the second period and consequently allow more consumers to satisfy their demand, resulting in higher total social surplus. Although restrictive zoning significantly increases profit under *public/owner*, it varies depending on how restrictive the zoning is. In general, *private/rental* generates highest profit. This example supports the common observation that most private communities are built for middle-upper class people and are mostly in the form of CIDs or condominiums, two types of *private/owner*.

Figure 4 shows how social surplus and profit change with the parameter for zoning restrictiveness. There is one local maximum for both social surplus and profit when beta is close to one. This appears to support the common observation that zoning tends to be very restrictive in affluent neighborhoods.

[Figure 4 around here]

In summary, the three numerical examples demonstrate the importance of consumer distribution to the efficient institutional arrangement. More uniform distribution of consumers, such as at large spatial scales, makes *public/owner* more efficient. Rental is more attractive for the community with a concentration of "poor" consumers. Integrated provision of land and collective goods in private communities may be closely related to the concentration of "rich" consumers. The presence of restrictive zoning is generally inefficient for more uniform distribution of consumers, but it may make the conventional form of local government more desirable for affluent communities.

DISCUSSION AND CONCLUSION

By focusing on intertemporal externality in the market of a bundle good of land and collective good, the two-period model developed in this paper revisits the Coase conjecture in its original example of land monopoly. The building block is that the transaction and consumption of land and collective good are bundled together but their provision can be separate. This fact provides the link among land market structure, intertemporal externality, and urban institutions.

The findings point to the importance of intertemporal externality in urban land development. In a world of rentals only, separate provision of land and collective good results in more land developed. This suggests that, *ceteris paribus*, proprietary communities that is based on leasehold and bundles the provision of land and collective good may result in less development than leasehold under traditional government provision of collective good. In the case of *private/rental*, the quality variable that stands for the collective good largely depends on how cost and WTP change relative to each other. Given the same quantity of land rented, public provision can tolerate a larger cost increase. In the case of sales, the interactions among land quantity and quality in the first and second periods become more complicated. With bundled provision of collective good, a larger cumulative quantity of land will be sold than what could be rented. Since non-durable collective good is bundled with land in their transaction and consumption, intertemporal competition is weakened and the monopoly power is strengthened. The result is more (or over) development. In the case of *public/owner*, collective good provision deteriorates in the second period if cost increases faster than WTP with regard to the quality, and vice versa if WTP increases faster than cost.

Findings from the model have important institutional implications about the relationship among urban spatial structure, urban institutions and local collective goods provision. Suburbs obviously face more competition than the city center, which enjoys significant monopolistic power. The analysis and the numeric examples suggest that, within some range of parameterization (such as uniform distribution of consumers), monopoly may cause public provision more desirable. The reasons for this result include (1) sale or homeownership creates intertemporal externality that is good for consumers; (2) bundling is instead good for the monopolist because it weakens intertemporal competition and emboldens time inconsistent behavior. This might be one reason why most private communities are located in the suburbs. A plausible explanation for the growth of private communities in the suburbs is that they are a new institutional form and most new developments are in the suburbs.[17] Therefore, most private communities are located in the suburbs. However, this argument does not hold in the case of urban renewal, and private communities such as company towns did exist in the history (Fishback 1992).[18] In this sense, this paper provides a competing hypothesis for the location choice of private communities. To some extent, this argument may also help to alleviate many people's concerns about monopoly in private communities because these institutional forms may only be able to thrive in a more competitive market.

The model also helps to explain why private communities remain at small scale while public institutions prevail at large spatial scales. The first numerical example shows that separate provision, or public institutions, can effectively mitigate this time-inconsistency problem at large spatial scales where consumers are more evenly distributed. This sheds light on the dominance of public institutions that conventional wisdom often takes for granted. Numerical examples also demonstrate the important role of consumer distribution. With a high

[17] I thank Peter Gordon for raising this point.
[18] Fishback's (1992) analysis indicates the important role of monopoly for company towns, where profit maximization as an objective certainly overrode other social objectives. Rental could also be attractive to companies in extractive industries in case they wanted to mine beneath the home sites.

concentration of "poor" consumers, such as company towns, *public* or *private/rental* can be quite efficient institutional forms. In contrast, a high concentration of "rich" consumers may make *private/owner* (such as CIDs and condominiums) more efficient. It is then not surprising that private communities are often characterized as "secession of the successful" (Reich 1991).

The introduction of zoning in the case of *public/owner* doesn't change much of the basic results from numerical examples. With uniform distribution of consumers that proxies the case of large spatial scale, restrictive zoning significantly reduces social surplus. For "rich" communities, it is shown that highly restrictive zoning may be a local equilibrium.

A key assumption in the model is that consumers can correctly anticipate the price in the second period. This is of course a strong assumption in land use, given the high heterogeneity of urban land. If this rational expectation assumption is relaxed, intertemporal competition will certainly become more weakened and the monopoly power will be strengthened. The result might be more sales (overdevelopment) in the second period, lower quality of collective goods, and then more conflict between the development interest and current residents.

There are many interesting issues deserving future research. First, the model is built on the assumption of a fixed group of consumers with a land monopolist. It will be interesting to explore other models such as oligopoly. Second, by relaxing the monopoly assumption, we can also take into account the effect of rent capitalization, which is essentially based on the mobility of consumers. Third, given the variety of collective goods, it is important to analyze the different impacts of different types of collective good. For example, some collective goods, such as transportation facilities, are durable. Durable collective good may actually weaken the monopoly power. Also, some collective goods may be congestible, especially after reaching some threshold. For example, environmental quality can be regarded as a collective good; it is then probably negatively related to land development or total population. This is certainly important to sustainable development, which is essentially about intertemporal issues over time.

APPENDIX

Proposition 1: when only rental is possible, what the land monopolist rents in the case of private provision of land and collective good is less than or equal to that in the case of public provision.

Proof: In the case of bundled provision of land and collective good, since hazard rate = $\frac{1}{\theta^*\left(1-\frac{C}{V\theta^*}\right)}$ and $\theta \in [0,1]$, obviously $1-\frac{C}{V\theta^*} \geq 0$ or else hazard rate would become negative.

Given that the hazard rate and θ are both within [0, 1], we must have $0 \leq 1-\frac{C}{V\theta^*} \leq 1$. Hence, we have

$$\frac{1}{1-\frac{C}{V\theta^*}} \geq 1 \tag{A1}$$

Because hazard rate and θ are both assumed to be non-decreasing, (θ · hazard rate) is also non-decreasing. Comparing condition (2) and (4), we can see that (θ · hazard rate) is bigger than 1 with bundled provision while it is equal to 1 with separate provision. Therefore, θ is not smaller in the case of bundled provision and the rental quantity $q = 1 - F(\theta)$ is then not larger.

Q.E.D.

Proposition 2: when only rental is possible, at equilibrium the first-order derivative of the ratio of cost vis-à-vis WTP (C/V) should be positive or equal to zero while the marginal cost has to be less than or equal to the marginal valuation.

Proof: Transforming (A1) yields $\frac{C}{V\theta^*} \leq 1$, and hence $\theta^* \geq \frac{C}{V}$. Comparing with (5) then yields $\frac{C'}{V'} \geq \frac{C}{V}$. Given that $V' \geq 0$ and $V \geq 0$, we have $C'V \geq CV'$. Thus, $\left(\frac{C}{V}\right)' \geq 0$. Because $\theta \in [0, 1]$, condition (5) also implies that $0 \leq \frac{C'}{V'} \leq 1$.

Q.E.D.

Proposition 3: with private provision of land and the collective good, the monopolist has cumulatively sold more land up to the second period than he rents in the rental case.

Proof: Rearranging the terms in (8) and (9) and then dividing them yields

$$\frac{V(Q_2)}{\theta_2 V'(Q_2)} = hazardrate \cdot \frac{\theta_2 V(Q_2) - C(Q_2)}{C'(Q_2)}$$

Substituting (9) into (A2) we can have

$$hazardrate = \frac{V(Q_2)}{\theta_2 V(Q_2) - C(Q_2)} \cdot \frac{F(\theta_1) - F(\theta_2)}{1 - F(\theta_2)} = \frac{V(Q_2)}{\theta_2 V(Q_2) - C(Q_2)} \cdot \frac{q_2}{q_1 + q_2} \qquad \text{(A2)}$$

Because $\frac{q_2}{q_1 + q_2} < 1$, $\frac{1}{1 - \frac{C}{V\theta}}$ is a decreasing function of θ, and ($\theta \cdot$ *hazard rate*) is a non-decreasing function, then comparing (A2) and (4) shows that θ_2 is smaller now than in the rental case (also with bundled provision).

Q.E.D.

Proposition 4: the relationship between quality and quantity in the first period are the same in the private/owner and private/rental cases. If the second-order effects can be ignored *and $\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)$ has different signs from $\theta_2 V' - C'$, the first-period θ_1 in the sale case is larger (i.e., smaller q_1) than in the rental case.*

Proof: It is easy to see that the first-order conditions (5) and (14) are essentially the same. If the second order effects can be assumed to be ignorable, substituting (17) into (18) and rearranging the items yields

$$\theta_1 = \frac{1}{V(Q_1)}\left\{C(Q_1) + \frac{V(Q_1)}{h(\theta_1)} - \delta\left[\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)\right]\cdot\frac{\theta_1 V'}{\theta_2 V' - C'}\right\} \tag{A3}$$

Obviously, (A3) is exactly the same as (4) except the last item, which is positive if $\theta_2 V(Q_2) - \frac{V(Q_2)}{h(\theta_2)} - C(Q_2)$ and $\theta_2 V' - C'$ have different signs. Given the non-decreasing assumption of the hazard rate, the sum of the first two items in (A3) is non-increasing with regard to θ_1. By comparing (A3) and (4), it is then easy to see that θ_1 will be larger in the *private/owner* case than in the *private/rental* case.

Q.E.D.

Proposition 5: in the case of public/owner, if there is no negative sale (buy-back) in the second period, the change of quality from the first period to the second period depends on how $\frac{C'(Q)}{V'(Q)}$ decreases. If marginal cost increases faster than marginal WTP with regard to Q, then quality declines in the second period; if marginal cost increases slower than WTP, then quality rises in the second period.

Proof: Transforming (3) yields

$$\frac{\overline{\theta}^*}{1-F(\theta^*)}=\frac{C'(Q)}{V'(Q)} \tag{A4}$$

It's then obvious that when θ decreases from θ_1 to θ_2, the left-hand side of (A4) becomes smaller, meaning that $\frac{C'(Q)}{V'(Q)}$ has to decrease in the second period.

Q.E.D.

Table 1: Summary of Governance and Land-tenure Options

	Provision	Land	Provider of Collective Good
public/rental	Separate	Rental	Government
private/rental	Bundle	Rental	Monopolist
public/owner	Separate	Ownership	Government
private/owner	Bundle	Ownership	Monopolist

Table 2: Results of the Numerical Examples

	θ_1	θ_2	Q_1	Q_2	Profit	Social Surplus
Uniform Distribution						
Public/rental	0.5	0.5	0.75	0.75	1.1875	2.0625
Private/rental	0.5486	0.5486	0.5486	0.5486	1.5340	1.8934
Public/owner	0.5706	0.2853	0.7853	0.6427	1.5448	2.1530
Private/owner	0.3741	0.7692	0.3741	1.3166	0.9784	1.6401
Public/owner with zoning:						
max					1.6296	1.5741
min					0.3914	0.3108
"Poor" Community						
Public/rental	0.3333	0.3333	0.5556	0.5556	0.6474	1.2621
Private/rental	0.3660	0.3660	0.3660	0.3660	0.8038	1.1603
Public/owner	0.4299	0.1982	0.6199	0.4655	0.8261	1.2657
Private/owner	0.5329	0.7618	0.5329	2.1680	0.3017	0.4344
Public/owner with zoning:						
max					0.3272	1.5214
min					0.0001	1.5000
"Rich" Community						
Public/rental	0.5774	0.5774	0.1925	0.1925	1.7866	0.5628
Private/rental	0.6465	0.6465	0.6465	0.6465	2.4782	0.6999
Public/owner	0.7521	0.4342	0.6528	0.0673	1.8320	0.8653
Private/owner	0.6361	0.9033	0.6361	2.0201	1.2515	2.5374
Public/owner with zoning:						
max					4.1764	2.2552
min					0.2460	0.7346

Figure1: Consumer Distributions in the Numerical Examples

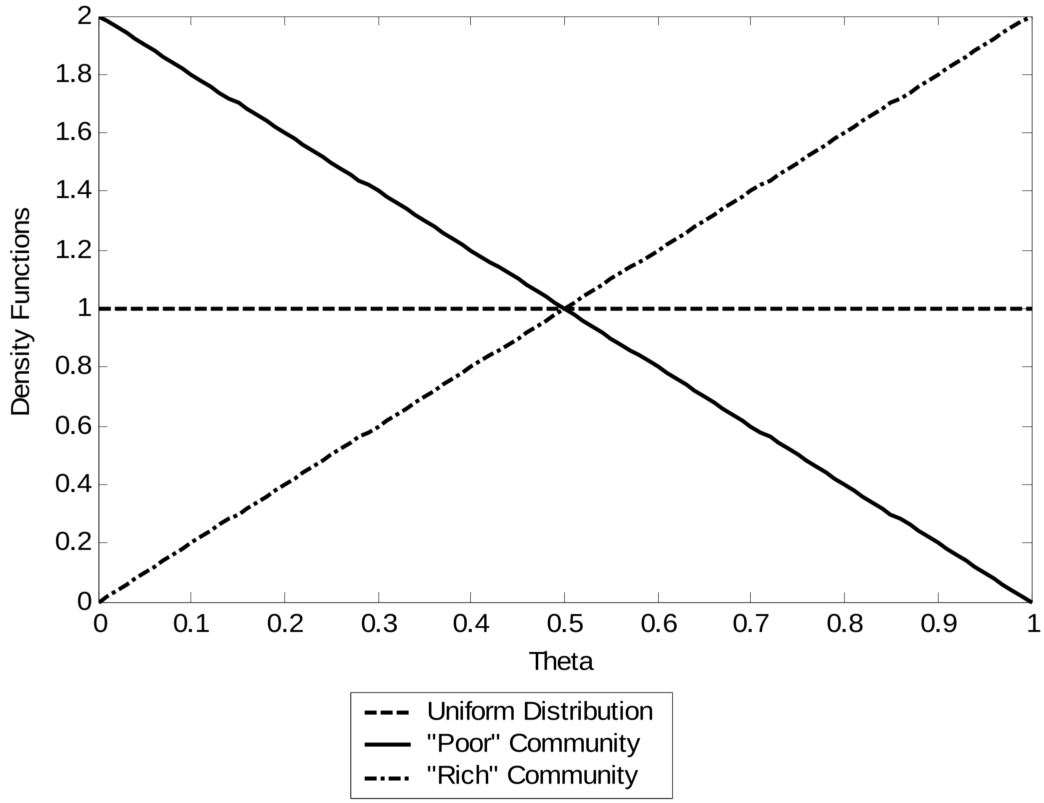


Figure 2: Change of Social Surplus and Profit with Zoning Restrictiveness
Uniform Distribution

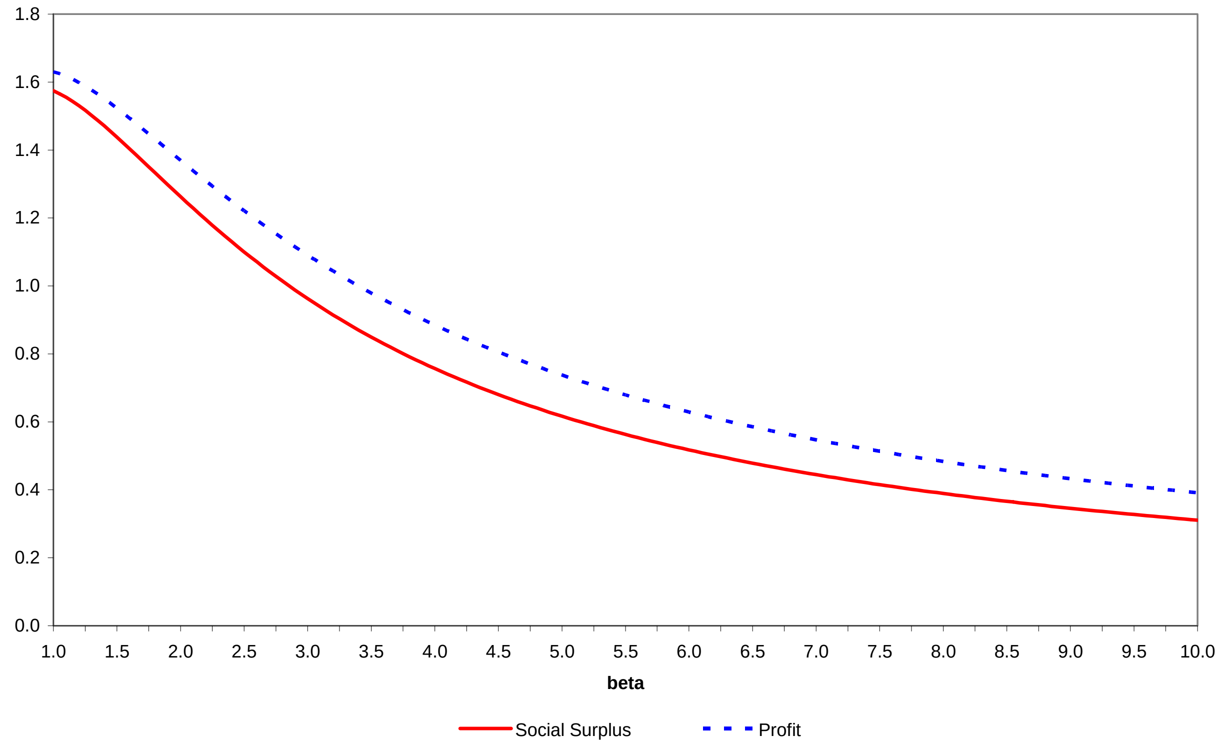


Figure 3: Change of Social Surplus and Profit with Zoning Restrictiveness
"Poor" Community

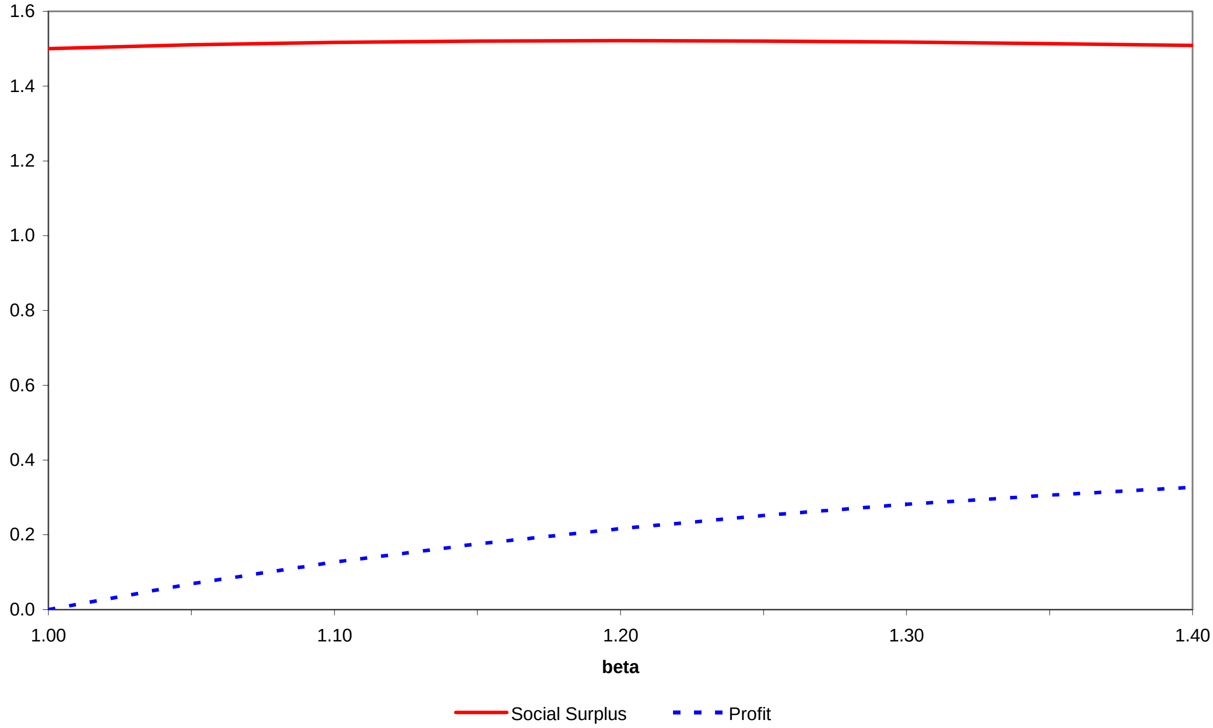
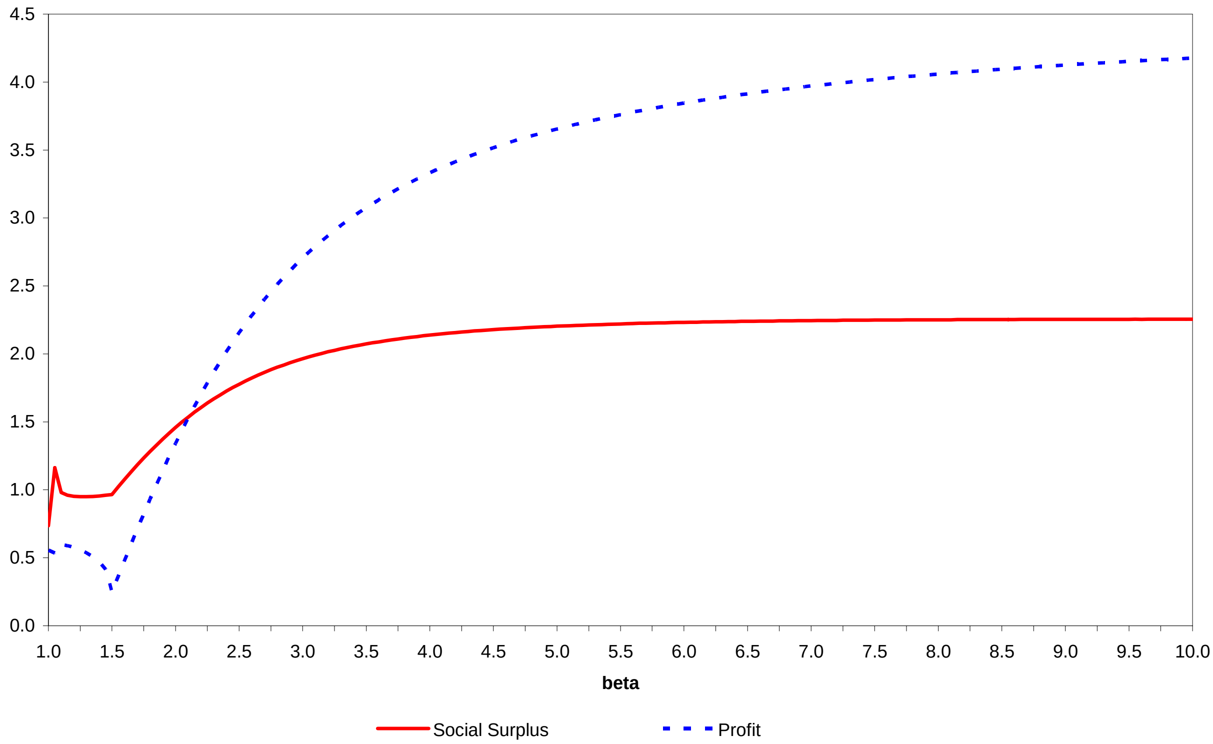


Figure 4: Change of Social Surplus and Profit with Zoning Restrictiveness
"Rich" Community



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