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# NONPROFIT AND FOR-PROFIT COMPETITION WITH PUBLIC ALTERNATIVES IN AN URBAN SETTING WITH CONGESTION

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*This theoretical analysis describes nonprofit-public and for-profit-public competition in an urban setting. The model resembles a Hotelling game with endogenous firm location, prices, and facility congestion. Because residents have free mobility, rent is also endogenous. The analysis identifies the optimal spatial and pricing configuration, against which nonprofit-public and for-profit-public competition are compared. If there is no congestion, both types of public-private competition are equivalent if profits are ignored. Neither type of public-private competition is optimal. However when congestion is present, nonprofit-public competition improves overall welfare in comparison to for-profit-public competition. The analysis identifies optimal subsidies and zoning rules that induce welfare-improving behavior on the part of either type of competition.*

***Keywords:*** *spatial competition; health care; hospital; public; private; nonprofit*

## 1. INTRODUCTION

Both the public provision of private goods and the private provision of local public goods have attracted some attention of late. For instance, many public choice models of public provision of private goods have begun appearing (Epple and Romano 1996, 2003; Blomquist and Christiansen 1999). However, the literature has thus far largely abstracted from several important factors.

The literature could be more realistic in many ways. First, the literature has thus far ignored public-private competition.[1] This is increasingly important with

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publicly provided private goods. For instance, consider the new Medicare bill, which allows private firms to compete with the federal government to provide health insurance coverage. Second, not all of the private firms in are profit-maximizers. Nonprofit organizations (nonprofits) also compete to sell local public goods or private goods. Most large American cities feature at least one prominent nonprofit hospital, high school, or university. Finally, spatial competition occurs in the public-private competition (see, e.g., Nilssen and Sorgard [2002] or Matsushima and Matsumura [2003] for a circular city case). For instance, private schools often enter markets where public schools exist. There will be a strong spatially competitive element to their location decision. Public-private spatial competition is also quite relevant for club theory (Buchanan 1965) and Tiebout economies (Tiebout 1956).

This article considers for-profit firms spatially competing with public firms (public-for-profit) and nonprofit firms spatially competing with public firms (public-nonprofit). A planner's solution offers the optimal solution, against which public-for-profit and public-nonprofit are compared. As described below, the model features a rent gradient. Facility congestion is also a feature of the model.

Although education is also a good example, the model presented here most closely resembles hospital markets. Approximately 70 percent of American hospitals are nonprofit, approximately 15 to 20 percent are for-profit, and the remainder are public (American Hospital Association [AHA] 1997). Hospital markets are also spatially competitive, with observable patterns of location in many cities, where public hospitals and nonprofit hospitals tend to located in the urban center; for-profits are newer and tend to locate in the suburbs (Pauly 1987). Finally, congestion and time costs are important parts of health care costs (see, e.g., Acton 1975). Kohlberg (1983) considered the profit-maximizing case with congestion in spatial competition.

Because of legislation, public prices and locations, such as in hospital markets, are often difficult to change in comparison to nonprofits or for-profits. Thus, one could think of public firms as "fixed" inexpensive alternatives to private firms, which may effectively anchor prices that private firms charge. This article focuses on the important case where the public firm is a "passive first-mover" in its price-location choice. The public firm(s) in this model are centrally located.

Because of the passivity of public firms, private competitors may be able to dramatically raise congestion levels at public facilities through their own pricing and location decisions (see Iversen [1997] for for-profit-public competition with congestion; his model is nonspatial). In the health care sector in many countries, the debate over whether public-private competition lowers or raises overall congestion in comparison to public-only provision is quite contentious (again see Iversen 1997).

It is known that spatial competition among two for-profit firms (for-profits) is inefficient due to inefficient location choices (Hotelling 1929; D'Aspremont, Gabszewicz, and Thisse 1979). However, much less is known about spatial competition among nonprofits, but it is hard to imagine that it is efficient. However, because public-private spatial competition differs in comparison to for-profit versus for-profit spatial competition, public-private spatial competition may offer some second best qualities. Public-nonprofit competition may differ in still other ways.

Although it is agreed that nonprofit hospitals face break-even constraints, health economists do not agree upon the objective of nonprofits (Newhouse 1970; Pauly 1987). This article focuses on output maximization. While quality is another candidate, it is negatively correlated with congestion in health care, which is included in the model.[2]

Given differences in their objectives, for-profits and nonprofits may compete differently with publics. On one hand, for-profits may charge relatively high prices, especially when congestion is high. Under public-for-profit spatial competition, for-profits may also spatially avoid publics, as is observed when for-profit hospitals compete with public hospitals (Pauly 1987). On the other hand, output-maximizing nonprofits may charge relatively low prices when spatially competing with publics, even when congestion is high. In terms of the locational pattern that emerges from public-nonprofit spatial competition, consider hospitals, where nonprofits and publics tend to locate closer to the downtown area relative to for-profits (Pauly 1987). Clearly, consumers, landowners, and firms will differ in their preference for type of competition.

Oates (1967) has empirically shown that access to local public goods is capitalized into higher property values. Similarly, in some models of for-profit competition, free mobility of consumers means that the advantages of locations near "stores" are capitalized (e.g., Fujita and Thisse 1986). One recent model has united parts of the urban and public economics literatures by introducing local public goods into a standard model of private spatial competition (Thisse and Wildasin 1992).[3] Unlike Thisse-Wildasin, the model presented in this article considers situations where for-profits and publics are direct spatial competitors for local public goods sold both privately and publicly. The results obtained are the first to show the effect of public-for-profit and public-nonprofit spatial competition on the rent gradient.

The analysis first identifies the optimal urban configuration and pricing scheme. Then it considers public-for-profit and public-nonprofit spatial competition.

The results show that the type of public-private competition that is preferred depends crucially on the congestion level. The analysis identifies corrective subsidies as well as corrective delivered prices (base prices plus travel costs plus congestion costs) regulation for each ownership regime. The analysis also considers the effects of other policy instruments such as zoning and price controls.

The basic model of the article is presented in section 2. Section 3 discusses welfare and introduces corrective policies.

## 2. The Model

A fixed population of $\ell$ identical households reside in a linear urban area. Households, or consumers, consume land, health care, and an all-purpose good that is chosen as numéraire. Health care in this model is essentially a private good. Demands for land and for health care are perfectly inelastic, with units chosen so that each household consumes one unit of each commodity per period. In Appendix A, the assumption of inelastic demand for health care is relaxed in the planner's case. Assuming that all nonresidential activities have negligible land requirements, the urban area can be identified with the interval $[0, \ell\ 1]$. The regions that bound the urban area are readily inhabitable. Land is owned by absentee landlords. Each household is endowed with $T$ units of time, which is used either for travel, in queue for health care, or for work. All employment occurs at the central business district (CBD), and workers earn a wage of $w$. Each period, consumers make $t_w$ trips to work and $t_c$ trips to consume health care, and these trips cannot be combined. Assume that each unit of round-trip distance traveled requires one unit of time. Consumption of health care also requires wait or queue times, which increase as more consumers use a given facility.

Time costs can be modeled in several alternative ways. For instance, time costs can be modeled as a step function where they are initially negligible, increasing infinitely beyond a certain distance or level of congestion. Time cost functions can also increase continuously. In the present model, travel and congestion costs increase linearly. Congestion costs are assumed to be proportionate to the number of customers at the facility, with a factor of $\alpha$ proportionality. However, the analysis will suggest how the results would change if time cost functions were nonlinear.

Because consumption of land and health care is fixed, consumption of the numéraire $\bar{c}$ measures consumer welfare. A government-operated facility at the center of the urban area provides health care free of charge. A household located at a point $\xi \in [0, \ell\,]$ thus spends $(t_w + t_c)\,|\,\xi - \ell/2\,|$ units of time in travel, $\alpha t_c \ell$ time in queue for health care, and earns an income of $w(T - [(t_w + t_c)\,|\,\xi - \ell/2\,| + \alpha t_c \ell\,])$. In equilibrium, land rents adjust to make all locations equally desirable, which means that households at all locations must consume the same amount $\bar{c}$ of the numéraire good. Hence, the equilibrium land rent facing a household at location $\xi$ must be given by

$$R(\xi) = w(T - [(t_w + t_c)|\xi - \frac{\ell}{2}| + \alpha t_c \ell]) - \bar{c}. \tag{1}$$

In equilibrium, rents are lowest at locations with the highest time costs. If land at the edge of the urban earns a rent of $\bar{R}$ in its best alternative use (e.g., agriculture), then arbitrage at the urban fringe will ensure that the minimum equivalent value of urban rent will be $\bar{R}$. We may normalize $R \equiv R(0) = R(\ell\,) = 0$ for simplicity. Because households agglomerate around $\ell/2$ to minimize travel times, households at locations 0 and $\ell$ face the highest travel costs and thus pay no rent, as illustrated in Figure 1. It then follows from equation (1) that

$$\bar{c} = w(T - (t_w + t_c)\frac{\ell}{2} + \alpha t_c \ell) \tag{2}$$

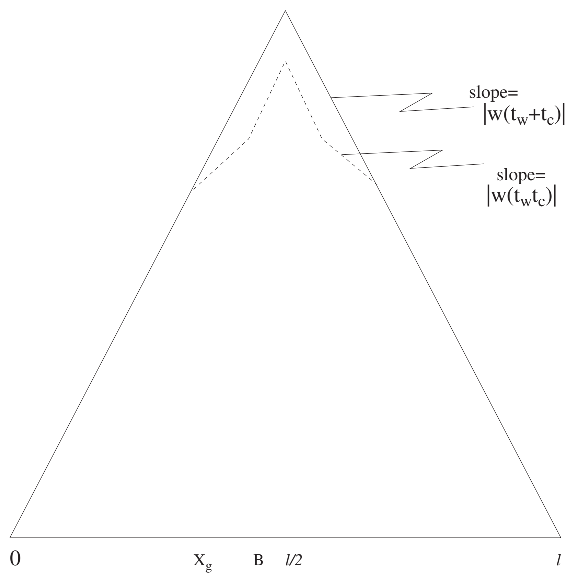


**FIGURE 1. The Rent Gradient, with Rent Measured on the Vertical Axis**

for the household at location 0.

Figure 1 illustrates the equilibrium rent gradient with a single health care facility at the city center. As one moves rightward from any point towards the CBD, rent increases at a rate equal to $w(t_w + t_c)$, which is the solid, unkinked line, because a unit move in that direction lowers travel costs to the public facility by that amount. The area of the triangle with the solid lines in Figure 1 represents total land rents, *TLR*, which determines the welfare of absentee landowners. Notice that because congestion costs are the same for all users of a given facility, they are invariant across locations.

### *2.1. Planner's Solution*

It is known that for-profit location decisions are not efficient. However, the potential second-best efficiency of nonprofits and public-private competition is unknown. To establish a first-best outcome, assume that a planner establishes two facilities in the urban space to maximize aggregate welfare, given the existence of a free public facility fixed at the city center. Publics are also often centrally located, so this framework is defensible (Pauly 1987).

In the next three sections, firms and consumers choose their locations in a two-stage process. In this section, the planner sets prices and locations for the three facilities. Then, consumers select where to live and which facility to purchase from in the second stage. In sections 2.2 and 2.3, either for-profits or nonprofits choose their respective locations and prices given the choices of their opponents, which will be for-profit in the for-profit regime and nonprofit in the nonprofit regime, and the location and price of the public facility. Then, as above, consumers select where to live and which facility to purchase from in the second stage. Note that both the spatial competitors' price and location choices and consumers' location choices are Nash equilibria.

Our objective is to evaluate the welfare of three groups (consumers, landowners, and private firms), in different ownership regimes. As mentioned earlier, all consumers receive $\overline{c}$ dollars worth of numéraire consumption, which is the measure of consumer welfare. Landowners receive rents totaling *TLR* dollars. Finally, private firms receive profits. If we assume lump-sum taxation is available, perfect income redistribution is possible so that maximizing aggregate income is the optimal solution. All work still occurs at the CBD.

Assume that health care provision entails fixed costs of *f* and that the marginal cost of producing health care is zero. With no profits, the planner's objective function is the sum of consumer and landowner welfare, as given by

$$W = \ell\,\overline{c} + TLR - 2f. \tag{3}$$

The instruments are location and price. If the hypothetical planner sets prices above marginal production cost, $\overline{c}$ would fall in equation (3).

The optimal locations and their implications are as follows. The details of this analysis, which are omitted for brevity, are available from the author. Note that $x_g$ refers to the left-most facility. Also note that in the maximization problem the right-most location is symmetric and therefore trivial. However, including the right-most facility imposes few computational or expositional burdens.

*Proposition 2.1:*

(*i*) Aggregate welfare is maximized when the facilities are located at ($\ell/6$, $\ell/2$, $5\ell/6$). Both aggregate travel and congestion costs are minimized with this configuration.
(*ii*) Consumer welfare is maximized when the facilities are located at ($\ell/6$, $\ell/2$, $5\ell/6$).
(*iii*) Landowner welfare is maximized when the facilities are located at ($\ell/2$, $\ell/2$, $\ell/2$) where aggregate *travel* costs are maximized. Congestion costs are minimized at this location.[4]

Notice that Proposition 2.1 (*i*), (*ii*), and (*iii*) hold for a variety of increasing travel or congestion cost functions. Consider, for example, convex and concave travel cost functions. In either case, travel costs are still minimized if facilities are located at ($\ell/6$, $\ell/2$, $5\ell/6$). Therefore, aggregate travel costs are minimized. Furthermore, if the congestion cost function is convex or concave, consumers would split evenly between facilities so that congestion costs are minimized. Proposition 2.1 (*iii*) holds for any monotonically increasing travel cost function because ($\ell/2$, $\ell/2$, $\ell/2$) always maximizes travel costs for the reference consumer so that *TLR* is maximized. To appreciate Proposition 2.1 (*iii*), consider the effect of dispersing two facilities symmetrically about the CBD on *TLR*. Because some users left of the

CBD backtrack to use the left-most facility but still must travel to the CBD for work, *TLR*is smaller. This is illustrated in Figure 1, where the slope of the dotted line right of $x_g$ but left of $\beta$ declines to $|t_w - t_c|$. If the travel cost functions were nonlinear but increasing, the result for *TLR* would hold.

In Appendix A, the results with obtained here with inelastic demands are shown to be equivalent to Cobb-Douglas utility functions.

Note that the optimal solution would not change with either congestion pricing or endowing the planner with the ability to dictate facility choice to individual consumers. This is because the solution minimizes travel costs and congestion costs simultaneously so that there is never an incentive to switch facilities based on either type of costs. In this solution, marginal congestion costs are equal across facilities.

### 2.2. *For-Profit*

This section characterizes an equilibrium associated with two for-profit firms competing with a single public facility. Two for-profits simultaneously locate in the urban space, setting price $p_m$. For simplicity, this price is a membership fee per period, where $t_c$ trips are included. Let us observe that the for-profits will choose to locate on opposite sides of the central public facility. If instead they locate on the same side of the urban space, they cannot avoid direct strategic interaction. Furthermore, both for-profits would concede half of the households to the public facility. For these reasons, both firms locating on one side of the CBD cannot represent a profit-maximizing strategy. The firms will also locate symmetrically about $\ell/2$ and charge identical prices. If they do not, profits on one side of the urban space will exceed those on the other, which violates profit-maximization for one of the firms. Thus we can once again focus attention on the location of the left-most facility, denoted $x_m$.

The consumer at location $\xi$ will select the for-profit facility if it offers the lowest total health care cost, that is, if

$$wt_c|x_m - \xi| + \alpha wt_c\beta + p_m \leq wt_c\left|\frac{\ell}{2} - \xi\right| + 2\alpha wt_c\left(\frac{\ell}{2} - \beta\right), \tag{4}$$

where the market area of the for-profit is then defined by the value of $\beta \equiv \psi(p_m, x_m, \alpha)$ at which equation (4) holds as an equality. Note the $t_w$ does not appear in equation (4) because travel to work is exogenous to health care provider choice.

To understand the firm's price function, consider Figure 2, where we assume $p_m$ is fixed at $\overline{p}_m$ and $\alpha = 0$ (no congestion). The line with slope $wt_c$ emanating from $\ell/2$ in Figure 2 represents the costs of traveling to the free public alternative in the CBD from each location left of the CBD. If the firm chooses location $x_m^o$ with fixed price $\overline{p}_m$, the boundary of its market area will be $\beta_m^o$. The household at location $\beta_m^o$ is indifferent between the public and private firms. This means that equation (4) holds as an equality at $\beta_m^o$. Note that in this case, the public facility is cheaper for all households

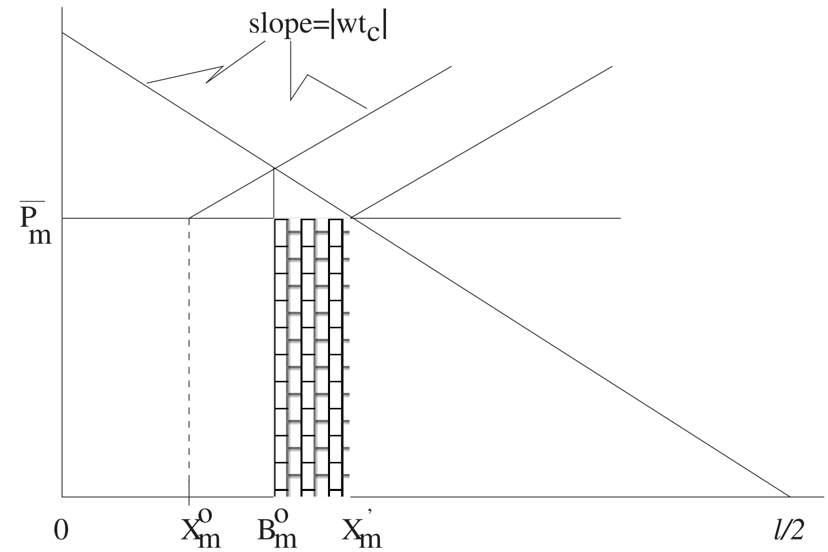


**FIGURE 2. The For-Profit Pricing and Location Strategy**

to the right of $\beta^o_m$. If the firm moves rightward from location $x^o_m$ to location $x'_m$ while holding the price constant, its revenue increases by the amount of the area shaded by the vertical brick pattern in Figure 2. Notice that at that point, $\beta = x'_m$. Of course, locations to the right of $x'_m$ the free public alternative is always cheaper given $\overline{p}_m$ so that profits are zero. Therefore, the price-location combination will occur along the travel cost line with slope $wt_c$. Note that $\beta = x_m$ for all of these price-location combinations.

Without congestion ($\alpha = 0$), substituting $x_m$ for $\beta$ in equation (4) yields the price function

$$p_m = \phi(x_m) = wt_c\left(\frac{\ell}{2} - x_m\right). \tag{5}$$

The argument is the same when congestion is present. We can replace $\beta$ with $x_m$ in equation (4), so that the profit-maximizing pricing function becomes

$$p_m = \phi(x_m, \alpha) = wt_c\left((2\alpha + 1)\frac{\ell}{2} - (3\alpha + 1)x_m\right). \tag{6}$$

This is illustrated in Figure 3. The vertical distance between the solid travel cost line with slope $|wt_c|$ and the dotted line with slope $|wt_c(3\alpha + 1)|$ is the value of the congestion time savings, or dis-savings, at the for-profit versus the public facility. This is the for-profit price, henceforth referred to as “full extraction” because the for-

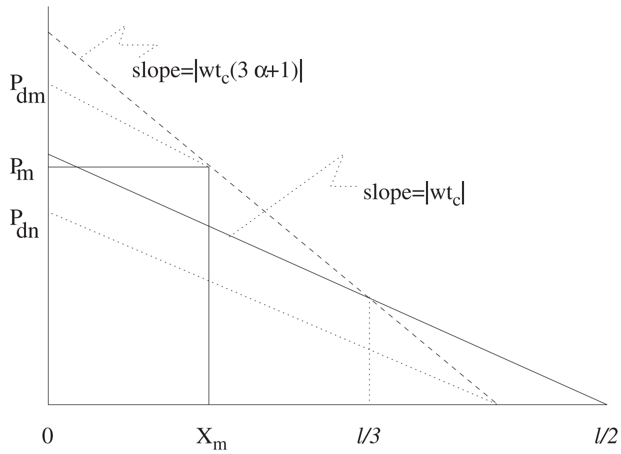


**FIGURE 3. The For-Profit Pricing and Location Strategy**

profit captures all travel and congestion cost savings available at the for-profit facility versus the public facility whenever *all* households left of $x_m$ use the left-most facility. Notice that the person at location 0 pays a delivered price of $p_{dm} = p_m + wt_c x_m$. Consumers at locations within the interval $[x_m, \ell/2]$ prefer the public.

Notice that the heavy dotted line becomes steeper as congestion increases, but always intersects the travel cost line at $x_m = \ell/3$. This is because congestion costs are equal at the public and the for-profit when $\beta = x_m = \ell/3$. At $\beta = x_m = \ell/3$, each facility serves one-third of the households, thereby minimizing time costs. Therefore, at locations $x_m \in [0, \ell/3]$, the for-profit charges a premium for congestion avoidance; at locations $x_m \in [\ell/3, \ell/2]$, the for-profit discounts for higher congestion at its own facility.

At locations $x_m \in \left[\frac{\ell(2\alpha+1)}{2(3\alpha+1)}, \frac{\ell}{2}\right]$, which occurs at the point where the heavy dotted line with slope $wt_c(3\alpha + 1)$ is below the $x$-axis (not shown), the firm cannot charge a positive price.[5] Thus, the location cannot occur within this region.

In the no-congestion case, the price function given by equation (5) would be discontinuous because consumers become indifferent between for-profit and public alternatives when the for-profit price-location combination approaches the travel cost line, leading to sudden changes in market shares if, as is standard in the literature, indifferent consumers split equally between alternatives. However, let us assume that the public facility is fixed in location and price for the duration of the analysis, perhaps because of legal reasons. This would enable the for-profit to slightly underbid the delivered price of the public, thereby always obtaining indifferent consumers and hence avoiding discontinuities in the profit function. Therefore, the for-profit firm gets all consumers located left of $x_m$. This is referred to henceforth as the underbidding assumption.

Let us now determine location.

*Proposition 2.2:* For-profit firms locate exactly at the quartiles with no congestion and

$$x_m = \left( \frac{\ell(2\alpha + 1)}{4(3\alpha + 1)}, \frac{\ell(10\alpha + 3)}{4(3\alpha + 1)} \right) \tag{7}$$

when there is congestion.

*Proof:* Substituting equation (6) into the profit function yields

$$\Pi = p_m\beta - f = p_m x_m - f = \phi(x_m)x_m - f = wt_c\left((2\alpha + 1)\frac{\ell}{2} - (3\alpha + 1)x_m\right)x_m - f. \tag{8}$$

The result follows from the first-order condition, with respect to $x_m$. Because $x_m \leq \left[\frac{\ell(2\alpha+1)}{2(3\alpha+1)}\right]$, the result holds. Q.E.D.

For-profit firms agglomerate closer to the CBD than in the planner's benchmark. The planner internalizes the congestion and travel cost externality, whereas the private firm does not.

This result is analogous to the theorem that monopolists always maximize revenue at the midpoint of linear demands.

The discussion of welfare in the for-profit case is deferred to section 3.

### 2.3. *Nonprofit*

This section characterizes the equilibrium associated with two nonprofits competing with a public. The fact that nonprofits earn zero profits may constrain prices. However, competition still occurs as nonprofits compete to maximize output.

With free entry, it may be that for-profit competition would drive out nonprofit firms. However, consider that nonprofits pay no income taxes and that for-profit entry can be restricted through "certificate of need" legislation. For simplicity, let us assume that in the nonprofit regime, for-profit competition is forbidden.

Newhouse (1970) first considered the objective of nonprofits. He suggested that nonprofit institutions such as hospitals and universities maximize output, quality, or a combination rather than profits. This leads to different pricing decisions as compared to for-profit firms. In this model, nonprofit firms maximize output.

Nonprofits must set price $p_n$ equal to average cost, $f/\beta$. For simplicity, this price is a membership fee per period, where $t_c$ trips are included. Each nonprofit will locate symmetrically on either side of the public facility to avoid direct competition as well as to avoid conceding half of the consumers to the public facility. If they do not locate symmetrically, output maximization is violated for one of the firms. Thus, we can once again consider only the left-most facility, $x_n$, whose direct competitor is the public facility at the city center.

Modifying equation (6) for the nonprofit case yields

$$p_n = \phi(x_n, \alpha) = wt_c\left((2\alpha+1)\frac{\ell}{2} - (3\alpha+1)x_n\right). \tag{9}$$

*Proposition 2.3:* Suppose f > 0. If maximum revenues exceed costs (Π > f), nonprofit firms locate nearer the CBD than for-profits at locations

$$x_n = \left(\frac{\ell(2\alpha+1)}{4(3\alpha+1)} + \frac{\left(\frac{wt_c\ell^2(2\alpha+1)^2}{16(3\alpha+1)} - f\right)^{\frac{1}{2}}}{4wt_c(3\alpha+1)}\right), \left(\frac{\ell(10\alpha+3)}{4(3\alpha+1)} - \frac{\left(\frac{wt_c\ell^2(2\alpha+1)^2}{16(3\alpha+1)} - f\right)^{\frac{1}{2}}}{4wt_c(3\alpha+1)}\right). \tag{10}$$

*Proof:* Take the positive root after solving for $x_n$ from setting average cost ($f/x_n$) equal to equation (9). By substituting equation (7) into (8) (the for-profit case), maximum revenues are $\Pi = \frac{wt_c(2\alpha+1)^2\ell^2}{16(3\alpha+1)}$, as in the numerator of the second term of equation (10). Q.E.D.

Nonprofits agglomerate closer to the center of the urban area than in the for-profit case, as illustrated in Figure 4. Let congestion be zero in that example. If maximum revenues, represented by areas *a* and *b*, exceed *f*, which equals areas *b* and *c*, the nonprofits locate nearer to the CBD than for-profits. If $a + b = f$, the nonprofit will replicate the behavior of the for-profit; if $a + b < f$, the nonprofit and for-profit firms will choose not compete with the public firm by entering the market.

Now consider the case where $f = 0$ so that $p_n = 0$. When there is no congestion, nonprofits locate slightly left and right of $\ell/2$, "book-ending" the public facility, so that the left-most facility obtains all households on the left-hand side of the urban space, or half of all households, by the underbidding assumption. However, using this location strategy when congestion is high yields only one-third of households because they would split equally among the two nonprofits and the public facility. By dispersing and discounting for the congestion at the nonprofit, output increases. This is illustrated by the point where the heavy dotted line with slope $wt_c(3\alpha + 1)$ meets the *x*-axis in Figure 3. The $f = 0$ locations are

$$x_n = \left(\frac{\ell(2\alpha+1)}{2(3\alpha+1)}, \frac{\ell(4\alpha+1)}{2(3\alpha+1)}\right). \tag{11}$$

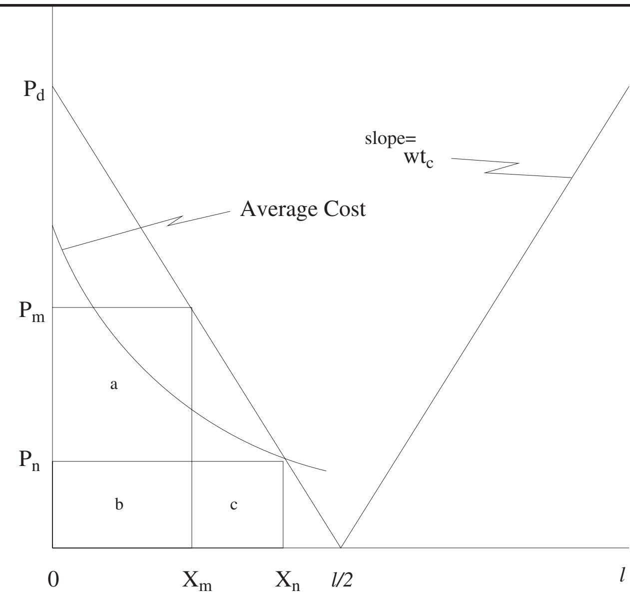


**FIGURE 4. Profits of the Left-Most For-Profit Compared to Revenues of the Left-Most Nonprofit**

Notice that congestion costs, but not travel costs, are minimized at this location when $\alpha$ is large.

Nonprofit firms are like for-profit firms in that they do not internalize the congestion costs they impose on the public firm. However, if congestion costs are high enough, they must location nearer the planner's solution because *their* congestion costs are high.

## 3. Equity and Efficiency Comparisons

This section compares the overall welfare associated with the two ownership regimes. The planner's solution with three public facilities as well as the configuration with one public facility and no private facilities serve as benchmarks in the welfare analysis.

*Proposition 3 (*i*):*

(*i*) When there is no congestion, consumers are indifferent between the nonprofit and the for-profit regime. Neither ownership regime offers higher consumer welfare in comparison to the configuration with one public facility.

(*ii*) When congestion is present, consumers prefer the nonprofit regime to the for-profit regime.

(*iii*) The nonprofit regime, the for-profit regime, and the urban configuration with one public facility all offer the same landowner welfare.
(*iv*) Either ownership regime offers higher consumer welfare in comparison to the configuration with one public facility.

*Proof:* Equilibrium consumption for private regimes is

$$\bar{c} = w\left(T - t_w \frac{\ell}{2} - t_c(\alpha + 1)x_i\right) - p_i,\ i = n, m. \tag{12}$$

Inserting prices for either regime, as given by equations (6) and (9), yields

$$\bar{c} = w\left(T - t_w \frac{\ell}{2} - t_c(1/2 + \alpha)\ell + 2\alpha t_c x_i\right),\ i = n, m. \tag{13}$$

Thus, $\bar{c}$ is increasing in $x_i$. Because $x_n \geq x_m$ by equations (10) and (7), part (*ii*) is true. Conversely, part (*i*) is true whenever $\alpha = 0$.

Now consider landowner welfare. The consumer located at $x_i$, $i = n, m$ is indifferent between the public and private alternatives, even when congestion levels vary between the alternatives. Therefore, the rent gradient is continuous at that point. Households just to the left of $x_i$, $i = n, m$ see their time costs fall by $wt_c$ as they move nearer the private facility. Likewise, households just right of $x_i$, $i = n, m$ see their time costs fall by $wt_c$ as they move nearer the public facility. Therefore, the rent gradient is unkinked at location $x_i$, $i = n, m$. Now let us determine the height of *TLR*. The consumer at location $\ell/2$ pays $2wt_c\alpha(\ell/2 - x_i)$ in congestion and travel costs for health care (this household pays no travel costs for work or health care), which is $wt_w + t_c\ell 1/2$ less than the reference consumer at location 0 by equation (13). Thus, the rent differential must equal $R(\ell/2) - R(0) = wt_w + t_c\ell/2$ to ensure equilibrium in the rent market. Thus the top, nonpiecewise, solid line of Figure 1 is the rent gradient, as was the case with the single public facility configuration. This is where *TLR* is maximized.

Now consider an urban configuration with only one public facility. Subtracting equation (2) from (13) yields $2\alpha t_c x_i$, $i = n, m$. Thus, either regime improves welfare in comparison to the configuration with one public facility. But if $\alpha = 0$, because of full extraction pricing, the reference household pays the same delivered price, $p_d$ for health care in either regime when $\alpha = 0$, as illustrated in Figure 4. Q.E.D.

Let $p_{dm}$ and $p_{dn}$ represent the delivered prices of for-profits and nonprofits, when $f = 0$ and congestion is high, for example. As illustrated in Figure 3, the for-profit locates at $x_m$ and charges $p_m$. The lightly dotted line represents the travel cost line so that the delivered price is $p_{dm}$. The nonprofit will choose the location given by equation (11) when $f = 0$, which yields a delivered price of $p_{dn}$. Thus, nonprofits offer higher consumer welfare. However, when congestion is zero, the delivered price is identical for either ownership regime, as illustrated by delivered price $p_d$ in Figure 4.

Note that congestion has no effect on *TLR* when private firms adopt full extraction pricing. Furthermore, for-profits, in contrast to nonprofits, also add profits to aggregate income.

Let us now compare the private regimes to the planner's solution.

*Proposition 3 (*ii*):*

(*i*) Landowners prefer either private ownership regime to the planner's solution with three facilities.
(*ii*) Consumers prefer the planner's solution with three public facilities to either ownership regime.
(*iii*) Neither ownership regime matches the aggregate welfare of the planner's solution with three facilities.

The proof appears in Appendix B.

In the planner's benchmark case, locational changes that improve consumer welfare come at the expense of landowner welfare. The solution balances the landowner and consumer welfare so that neither is maximized. However, public-private competition maximizes, unintentionally, *landowner and firm* welfare at the expense of consumer welfare. Because customers of private firms must pay a premium equal to the time cost savings gained by avoiding the public facility, private alternatives do not make them better off in comparison to a regime with one public. When congestion is high, private alternatives make them marginally better off. Therefore, land near the public facility retains its high value, unlike in the planner's benchmark.

As in the planner's case, many of the welfare results of public-private competition generalize to nonlinear travel functions. The prices and locations chosen with several nonlinear travel costs would change in comparison to the linear travel costs used thus far. However, because either ownership regime would still extract savings in travel costs to the public facility, the delivered price to the reference consumer does not change in comparison to a configuration with a single public facility. This also means that *TLR* would not change. Thus, Proposition 3 (*i*) holds. However, if congestion costs are nonlinear, there would be changes in the welfare results. Consider, for example, convex functions. Although either regime will extract travel cost savings so that *TLR* is unaffected, profits increase dramatically as congestion costs at the public facility increase. Thus, the for-profit regime would disperse its locations further, serve fewer customers, and charge higher prices, which would lower equilibrium consumption.

When congestion is low, the case for tax-exempt status for nonprofit firms has little merit within the present model. Consumer and landowner welfare are unchanged with fixed or profit taxes, as demonstrated by Proposition 3 (*i*). Notice also that charitable donations, which effectively lower average costs, also do not improve consumer or landowner welfare by Proposition 3 (*i*). Suppose the left-most nonprofit received absentee donations totaling $f$. It would then gain all of the customers on the left side of the urban space by locating slightly left of $\ell/2$ by equation (11). But consumer and landlord welfare would remain unchanged.

Notice that price regulation leads to deadweight losses when no congestion is present. Because of full extraction pricing, private firms will change locations in response to price controls. Therefore, consumer welfare does not improve even though profits fall. However, price regulation improves welfare when congestion is present. Even with full extraction, price regulation can induce locational changes that lower congestion costs. A consequence of full extraction pricing is that price regulation will not lower *TLR*.

Similarly, zoning leads to deadweight losses when no congestion is present in most cases. Firms still fully extract in many cases, leaving consumers no better off. However, at other locations, zoning induces firms to abandon full extraction pricing to increase market share. This is discussed in the next section.

## 4. Policy Instruments

The results of the analysis thus far suggest that most policy instruments are ineffective. For instance, suppose consumers received per-mile transportation subsidies for health, $t_s$. Prices would fall because time costs are subsidized by $wt_c(1 - t_s)$ in both equations (6) and (9). However, because both regimes would still fully extract, the reference consumer would gain only $wt_c(1 - t_s)\ell/2$ in consumption when there is no congestion. Therefore, the subsidy would not induce consumer benefits beyond the amount of the subsidy itself. Access to facilities is now less valuable so that *TLR* falls. The net gain in welfare is zero. However, the per-mile subsidy may reduce welfare when congestion is present in the nonprofit regime. Nonprofit regimes, unlike for-profit regimes, disperse their locations when transportation costs fall, thereby serving fewer customers, which would lead to a less efficient distribution of congestion.

Suppose instead that consumers received subsidies, $s$, for using the downtown public facility. Both ownership regimes would change prices and locations, which could improve efficiency. As $f$ increases, nonprofit behavior becomes identical to for-profit behavior. Therefore, let us set $f = 0$ in this section so the nonprofit chooses the locations given by equation (11).

*Proposition 4* (i)*:*

(*i*) For the nonprofit regime, the optimal subsidy is $s = wt_c\ell/4$. Lump-sum taxes pay for fixed costs, $f$. The subsidy improves consumer and aggregate welfare when congestion is high. Landowner income remains maximized.

(*ii*) For the for-profit regime, the optimal subsidy is $s = 0$. Thus, consumer, landowner, and aggregate welfare remain unchanged.

The proof appears in Appendix C.

The subsidy lowers the cost of using the public facility. However, when private firms fully extract, they discount for the subsidy so that private consumers are as well off as public consumers. Improving the welfare of the reference consumer by one dollar requires subsidizing all of the public customers by one dollar, making the subsidy quite expensive. In the case of for-profits, profits fall greatly as the for-profits disperse, offsetting the gains to consumers.

As given by equation (27) and $s$ in Appendix C, the nonprofit locates at

$$x_n = \left( \frac{\ell(4\alpha + 1)}{4(3\alpha + 1)}, \frac{\ell(8\alpha + 3)}{4(3\alpha + 1)} \right) \tag{14}$$

when the subsidy is offered. As congestion increases greatly, $x_n = (\ell/3, 2\ell/3)$, where congestion costs are minimized because each facility serves one-third of all households. However, even with the subsidy, the nonprofit regime does not match the planner's optimum in terms of consumer welfare because travel costs are not minimized.[6]

Because of full extraction, the difference in health care costs at locations 0 and $\ell/2$ remains unchanged after the subsidy is imposed. This implies that *TLR* does not change.

As pointed out earlier, efforts by health maintenance organizations, preferred provider insurance plans, or governments to lower the prices of for-profits or nonprofits in this model are only effective when congestion is high. This is because the ability to change locations leads to full extraction pricing. Furthermore, when congestion is low in the for-profit regime, profits fall so that price controls always cause deadweight losses.

Zoning would also leave welfare unchanged at some locations. As illustrated in Figure 5, a for-profit zoned for location $x_{mr}$ would fully extract by charging $p_{mr}$ so that the reference consumer pays $p_d^*$ for health care. Therefore, consumer welfare improves only if the zoning leads to a better distribution of congestion, as in the nonprofit-public regime. Even if consumer welfare remains unchanged with zoning, aggregate income may fall because profits fall. At other zoned locations, private firms would price below the full extraction line to increase market share, as illustrated by location $x_{mr2}$ and price $p_{mr2}$ in Figure 5. Zoning at that location improves consumer welfare because the reference consumer spends less on the delivered price of health care, $p_{d2}^* < p_d^*$ (see the $y$-axis of Figure 5). Without full extraction, *TLR* falls.

Rather than determining the optimal zoning law, let us simply identify the optimal delivered price $p_d$ to the reference consumer. Private firms are allowed to choose both price and location subject to the constraint that the reference consumer cannot pay more than a given delivered price for health care. The planner chooses the delivered price to maximize the sum of profits (in the case of the for-profit regime), consumption, and *TLR*.

*Proposition 4 (*ii*):*

(*i*) For the for-profit regime, the optimal delivered price is

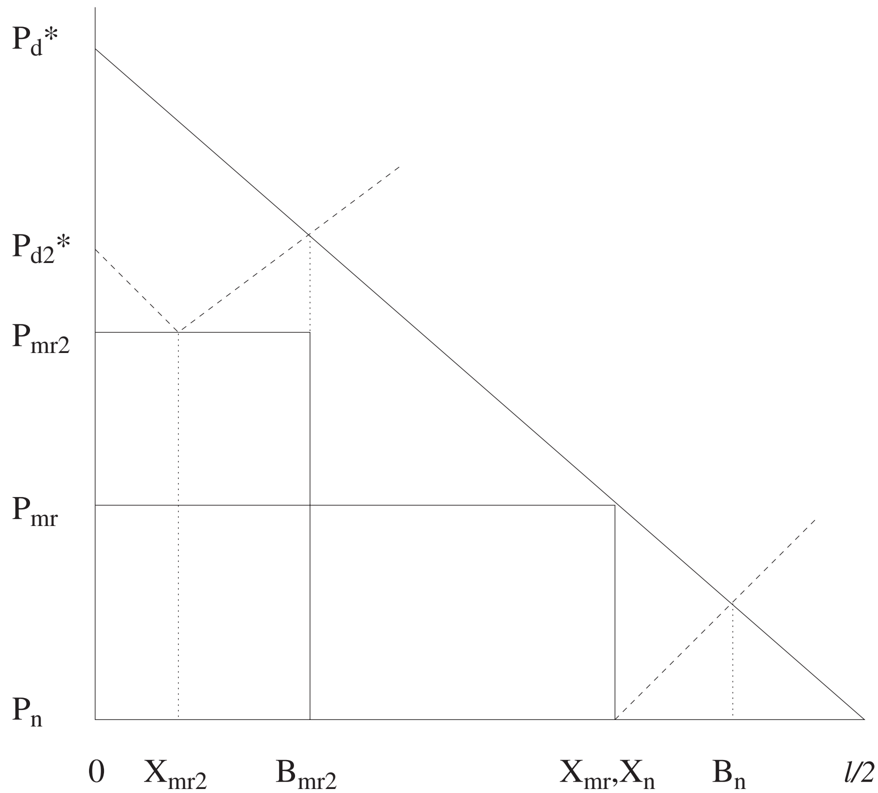


**FIGURE 5. Delivery Pricing with Zoning Laws**

*Cost to reference consumer.

$$p_d = \frac{wt_c\ell(48\alpha^3 + 96\alpha^2 + 59\alpha + 11)}{2(36\alpha^2 + 45\alpha + 13)}. \tag{15}$$

Consumers are better off with the delivered price but worse off in comparison to the planner's solution with three public facilities. Landlords are worse off with the delivered price regulation but better off in comparison to the planner's solution with three public facilities. Overall, the solution is not optimal in comparison to the planner's solution with three public facilities.

(*ii*) For the nonprofit regime, the optimal delivered price is $p_d = wt_c(\ell + 2\alpha)/6$ when $f = 0$. Consumers are as well off as they are in comparison to the planner's solution with three public facilities. Landlords are worse off with the delivered price regulation but fare the same as in the planner's solution with three public facilities. Aggregate income is maximized.

The proof appears in Appendix D.

If $f = 0$, the planner can use the delivered price strategy to attain the optimum in the nonprofit regime. The output-maximizing nonprofit locates at $x_n = (\ell/6, 5\ell/6)$ and charges $p_n = 0$ by average cost pricing. This solution is identical to the planner's solution with three public facilities. Notice that this approach is equivalent to the combination of zoning with public funding of fixed costs.

However, in either ownership regime where $f > 0$, the optimal delivered price cannot match the consumer welfare in the benchmark case. Suppose we adopt $p_d$ as the optimal delivered price when $f > 0$, as illustrated in Figure 5. Then either ownership regime will choose a location $x_i \in [0, \ell/6]$, $i = m, n$, so that it can charge a positive price $p_i$, $i = m, n$, as illustrated in Figure 5. The positive price changes market areas from β to β2. Therefore, time costs are not minimal and *TLR* may fall.

## 5. Conclusion

This article developed a theory describing imperfect competition in an urban setting between organizations with different objectives. The existence of a low-cost public facility at a fixed location alters the nature of the competition. To establish a first-best solution, a hypothetical planner places three public facilities in the urban space, maximizing the sum of consumer welfare, landowner income, and firm profits. The analysis then compares this solution with two ownership regimes: a regime where two for-profits compete with a single public facility and a regime where two nonprofits compete with a single public facility.

When there is no congestion, nonprofit regimes are less efficient than for-profit regimes. This is because profits fall in the nonprofit regime while consumers are not made better off because the delivered prices of each regime are equal. Even though each ownership regime chooses a different price/location combination, the reference consumer must pay for all travel costs savings gained by using the private versus the public facility. Therefore, consumers of either nonprofits or for-profits face the same delivered price. Landowner income does not increase in either ownership regime as compared to the configuration with only one public facility.

When congestion is present in the model, nonprofit regimes are more efficient than for-profit regimes, although they are not first-best efficient. Because they maximize output rather than profits, nonprofits have no incentive to increase the difference between congestion costs at their facility and the public facility. Thus, they tend to locate nearer to the CBD and serve more households than for-profits, resulting in lower overall congestion costs and higher consumer welfare. The nonprofit location and pricing scheme does not lower landowner welfare in comparison to the for-profit scheme.

Generally, private firms efficiently handle excess demand by raising prices. Indeed, in this model, private firms raise prices and relocate as congestion increases. However, the level of congestion at the public facility is endogenous to the pricing and location decisions of private firms. Therefore, for-profits have an incentive to exacerbate congestion costs by "dumping" patients on the public facility to increase the willingness to pay at their own facility. This is inefficient. Output-maximization, on the other hand, limits the incentive to "dump" consumers on the public facility. Note that nonprofit behavior becomes increasingly similar to for-profit behavior as fixed costs increase.

One would suppose that adding new private alternatives to the public facility in the urban center would alter the rent gradient because access to the public is less important. However, because of imperfect public-private competition, private firms extract all savings in travel costs that the private facilities afford so that private customers are not better off. Likewise, private firms extract all congestion cost savings their customers enjoy by avoiding the public facility. Therefore, landowner rent is maximized even with the addition of the private alternatives.

The analysis considers several traditional policy prescriptions. Most do not increase efficiency when congestion is low. Traditional price controls, for instance, may simply induce nonprofits and for-profits to change locations so that the reference consumer pays the same delivered price as without price controls. Likewise, zoning laws may simply induce nonprofits and for-profits to change prices so that the reference consumer pays the same delivered price as without zoning. However, there are cases where price controls and zoning laws can improve welfare. The analysis develops an optimal delivered price, whereby the private firm may choose a price and a location given a regulated delivered price to the reference consumer. When fixed costs are zero, delivered price regulation yields the first-best solution in the nonprofit regime.

The analysis also develops optimal subsidies for using the public facility. These subsidies induce welfare-improving location and pricing changes in the case of the nonprofit regime.

It is of interest to consider how health maintenance organizations (HMOs) and preferred provider organizations (PPOs) might affect the foregoing analysis. First, HMOs and PPOs may impose penalties for using particular facilities, possibly necessitating longer travel times for some customers. Thus, in contrast to the analysis above, contiguous consumers may use different facilities. As a practical matter, however, employees of a given firm providing a given insurance plan often live in the same neighborhoods. Because firms must offer a competitive compensation package, the health insurance they offer must include area hospitals. Therefore, as shown empirically by White and Morrisey (1998), patient travel times may not increase for consumers using HMOs and PPOs in comparison to consumers using traditional insurance. Second, HMOs and PPOs negotiate price cuts through selective contracting. The ability of private health care providers to set base prices is therefore limited. However, Melnick (1992) showed empirically that spatial monopoly power enhances the hospital's price bargaining position with HMOs and PPOs. Therefore, spatial monopolies still have price-setting ability.

In addition to health care, the model has implications for many other imperfectly competitive markets. For example, the model could be used to evaluate the welfare effects of changing from legislatively defined local school districts to a voucher system.[7] Vouchers would free consumers to choose from public, private, or nonprofit schools from all over the urban area, which would affect consumer, landowner, and firm welfare. Consumers of different income levels may prefer one regime over another.

In actual cities, there exist neighborhoods where consumers of a single income class reside. The introduction of income class to the model changes the location and congestion strategies of both ownership regimes, leading to different outcomes for different income classes. For-profits, for instance, may act to save time for high-wage consumers. However, for-profit regimes may lower congestion and travel *costs* because of the high value of time for high-wage consumers. If so, for-profit regimes may be efficient. The author has previously published an article on normative aspects of this topic (Brown 2002).

The treatment of household preferences for health care is very simple, allowing for neither income nor price to affect demand. Relaxation of this restriction is left for future research.

History has largely shaped the urban configurations modeled in this article. Public firms were often first established in the urban area, followed by nonprofits and for-profits. Although these configurations are stable for given periods, entry is likely to occur in the long run. Additionally, the sale of public firms may occur. Thus, direct competition among and between for-profits and nonprofits is likely to occur. An explicit treatment of the dynamic evolution of changes in organizational form in the urban health care sector could shed light on this process.

## APPENDIX A
## COBB-DOUGLAS UTILITY

Although many types of demand in health care are inelastic, such as cancer treatment, others, such as dental services, are not. This appendix considers Cobb-Douglas utility. In this example, it turns out that the results in the planning section for inelastic demand and Cobb-Douglas utility are equivalent.

Consider the person at location $\xi = 0$. With one facility, this is given by equation (2). With three facilities, this household uses the left-most facility, and consumes

$$c = w(T - t_w \ell / 2 - t_c[x_g + \alpha\beta]), \tag{16}$$

which also represents its utility level. Notice that the term in the squared brackets, times $wt_c$, $wt_c[\cdot]$, is the delivered price of health care. Of course, one unit of health care is consumed.

Now let the utility function be given by

$$U(h, c) = h^a \cdot c^{1-a}, \tag{17}$$

where $0 \leq a \leq 1$, $h$ is health care, and $c$ is the numéraire. Assuming an interior solution,

$$h = \frac{a \cdot (T - t_w \ell / 2)}{t_c [x_g \alpha\beta]} \tag{18}$$

and

$$c = (1 - a) \cdot w(T - t_w \ell / 2). \tag{19}$$

Notice that the denominator of equation (18) is the delivered price of health care. Indirect utility is

$$U = a^a \cdot (1 - a)^{(1-a)} \cdot \frac{w(T - t_w \ell / 2)}{t_c [x_g + \alpha\beta]}. \tag{20}$$

In terms of the rank order of utility, equations (16) and (20) are equivalent functions. Equation (20) is a log transformation, which is monotonic, of (16). One must merely add in the rent gradient. Therefore, qualitatively, the analysis holds for either utility functions because the same locations would be selected.

## APPENDIX B
## PROOF OF PROPOSITION 3 (*ii*)

(*i*) Note that *TLR* is not maximized in the planner's solution. Therefore, we must show that *TLR* is maximized in the private regimes. This was shown in Proposition 3 (*i*), part (*iii*).

(*ii*) When $\alpha = 0$, consumers are worse off than in the planner's solution by Proposition 3 (*i*). Suppose $\alpha > 0$. Consider the nonprofit regime when $f = 0$, which represents the highest level of consumer welfare by Proposition 3 (*i*). The left-most nonprofit locates at $x_n = \frac{(2\alpha + 1)\ell}{2(3\alpha + 1)}$ by (11) and charges $p_n = 0$. The limit of $x_n$ as $\alpha$ increases is $x_n = (\ell/3, 2\ell/3)$. Because of full extraction pricing, the left-most and right-most nonprofits serve one-third of the households so that congestion costs are minimized as in the planner's case. However, in the planner's solution, $x_g = (\ell/6, 5\ell/6)$ so that travel times are lower than in the nonprofit regime.

As $f$ increases, nonprofit location disperses from the above location. By Proposition 3 (*i*), consumer welfare declines. Likewise, for-profits do not match the consumer welfare of the planner's solution by Proposition 3 (*i*).

(*iii*) Substituting $x_g = \ell/6$ into equation (3) yields aggregate welfare for the planner's solution. Welfare in the for-profit case is sum of aggregate consumption, *TLR*, and profits, as given by

$$W = \ell\,\bar{c} + TLR + 2\Pi. \tag{21}$$

In the nonprofit case, profits are not relevant. Thus, equation (21) becomes

$$W = \ell\,\bar{c} + TLR. \tag{22}$$

The difference between the planner's solution and equation (21) is $\frac{w\ell^2 t_c(12\alpha^2+4\alpha+1)}{24(3\alpha+1)} > 0$. The difference between the planner's solution and equation (22) is $\frac{w\ell^w t_c(\alpha+1)}{6(3\alpha+1)} > 0$. Q.E.D.

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## APPENDIX C
## CORRECTIVE SUBSIDIES

*Proof of Proposition 4 (*i*):*

To determine which subsidy maximizes aggregate income, less the cost of the subsidy, the hypothetical planner must anticipate private firm behavior and subsequent changes in *TLR*.

Both the for-profit and the nonprofit fully extract, less the subsidy, so that equations (6) and (9) become

$$p_i = \phi(x,\alpha) = wt_c\left((2\alpha+1)\frac{\ell}{2} - (3\alpha+1)x_i\right) - s, i = m, n \tag{23}$$

with the subsidy. Note the full extraction implies that *TLR* does not change with the subsidy so that rent can be ignored. Finally, taxes in the amount of $2(\ell/2 - x_i) \bullet s$ must be collected to pay for subsidizing the $2(\ell/2 - x_i)$ consumers of the public facility.

Let us consider for-profits first. For-profits maximize profits using the pricing strategy given by equation (23) as in section 2.2. This yields location

$$x_m = \left(\frac{\ell(2\alpha+1)}{4(3\alpha+1)} - \frac{s}{2wt_c(3\alpha+1)}, \frac{\ell(10\alpha+3)}{4(3\alpha+1)} + \frac{s}{2wt_c(3\alpha+1)}\right), \tag{24}$$

so that the for-profit disperses with the increases in the subsidy. With equations (23) and (24), aggregate consumption can be derived from equation (12). It is increasing in *s*. However, profits,

$$\Pi^s = \frac{(wt_c\ell(2\alpha+1) - 2s)^2}{16wt_c(3\alpha+1)} - f, \tag{25}$$

are decreasing in *s*.

The hypothetical planner's solution is now a function of *s*. It is

$$\begin{aligned} W &= \ell \cdot \bar{c} + 2 \cdot \Pi^s - 2\left(\ell/2 - \frac{\ell(2\alpha+1)}{4(3\alpha+1)} - \frac{s}{2wt_c(3\alpha+1)}\right) \cdot s \\ &= \frac{8w^2t_c\ell T(3\alpha+1) - 3w^2t_c^2\ell^2(2\alpha+1)^2 - 8wt_c\alpha\ell s - 4s^2}{8wt_c(3\alpha+1)}. \end{aligned} \tag{26}$$

It is decreasing in *s* so that $s = 0$.

Now consider the nonprofit solution. Because $f = 0$, $p_n = 0$ in equation (23). Solving for location from the profit function yields

$$x_n = \left( \frac{\ell(2\alpha+1)}{2(3\alpha+1)} - \frac{s}{2wt_c(3\alpha+1)}, \frac{\ell(10\alpha+3)}{2(3\alpha+1)} + \frac{s}{2wt_c(3\alpha+1)} \right), \tag{27}$$

so that the nonprofit also disperses with increases in $s$.

With no profits, equation (26) becomes

$$\begin{aligned} W &= \ell \cdot \bar{c} - 2\left( \ell / 2 \frac{\ell(2\alpha+1)}{4(3\alpha+1)} - \frac{s}{2wt_v(3\alpha+1)} \right) \cdot s \\ &= \frac{2w^2 t_c \ell T(3\alpha+1) - w^2 t_c^2 \ell^2 (2\alpha+3\alpha+1) + 2wt_c \ell s - 4s^2}{2wt_c(3\alpha+1)}. \end{aligned} \tag{28}$$

From the first-order condition with respect to $s$, $s = wt_c\ell/4$. Q.E.D.

# APPENDIX D
# DELIVERED PRICE: PROOF OF PROPOSITION 4 (*ii*)

We have seen that the inefficiencies of public-private competition largely arise from full extraction pricing. Therefore, with delivered price regulation, we are trying to induce firms to price below full extraction. Let $p_d$, as illustrated in Figure 6, be the delivered price offered to the reference consumer. In Figure 6, $i = m, n$. With delivered price regulation, the firm can choose any price or location such that the combination does not exceed $p_d$.

(*ii*) If $f = 0$, the nonprofit will set $p_n = 0$. The optimal delivered price is the planner's solution in Proposition 2.1. Because the optimal locations are $x_n = (\ell/6, 5\ell/6)$, the delivered price is $p_d = wt_c(\ell + 2\alpha)/6$. Note that *TLR*f alls with this solution because it is equivalent to the planner's benchmark.

(*i*) Now let us consider the for-profit regime. From equation (4), one can solve for $\beta$ as a function of $p_m$ and $x_m$ assuming $\beta \le x_m$. Then, from the first-order condition of $\Pi = p_m\beta - f$ with respect to $p_m$,

$$\beta = \frac{2x_m + \ell(2\alpha+1)}{4(3\alpha+2)} \tag{29}$$

and

$$p_m = \frac{wt_c(2x_m + \ell(2\alpha+1))}{4}. \tag{30}$$

Now we can form the profit component of the objective function. Notice that $\beta = \beta 2$ in Figure 6.

Now let us find equilibrium consumption. By modifying equation (2),

$$\bar{c} = w\left( T - t_c x_m - \alpha t_c \left[ \frac{x_m}{2(3\alpha+2)} + \frac{\ell(2\alpha+1)}{4(3\alpha+2)} \right] \right) - \frac{wt_c(2x_m + \ell(2\alpha+1))}{4}. \tag{31}$$

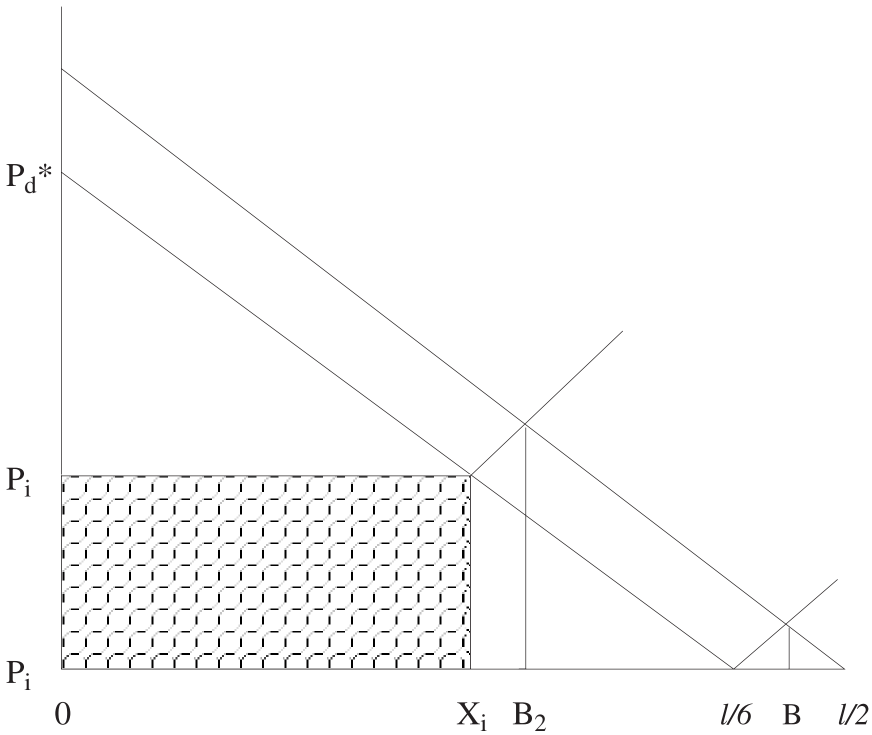


**FIGURE 6. Optimal Delivered Price**

*Cost to reference consumer.

Finally, *TLR* is calculated in the same manner as in the planner's solution with three facilities. The objective function becomes

$$W = \ell c + 2\Pi + TLR =$$

$$w\left(T - t_c x_m - \alpha t_c\left[\frac{x_m}{2(3\alpha+2)} + \frac{\ell(2\alpha+1)}{4(3\alpha+2)}\right]\right) + wt_c x_m(\ell - x_m)$$

$$+2\frac{wt_c(2x_m + \ell(2\alpha+1))^2}{16(3\alpha+2)} \tag{32}$$

$$+wt_c(\beta - x_m)(\ell - 2x_m - (\beta - x_m))$$

$$+wt_c\left(\frac{\ell}{4} - \frac{x_m}{2}\right)^2,$$

where $\beta$ is given by equation (29) for simplicity. From the first-order condition with respect to $x_m$, $x_m = \frac{\ell(12\alpha^2+13\alpha+3)}{72\alpha^2+90\alpha+26}$. The delivered price follows.

Although consumers are better off with the delivered price regulation by equation (31), they are worse off in comparison to the optimal configuration with three facilities.

We can see that landowners are worse off with delivered price regulations. However, landlords prefer delivered price regulation to the planner's solution. Finally, profits fall with delivered price regulation.

## NOTES

1. See, for example, Boadway, Marchand, and Tremblay (2003) for a model of private provision of private goods with information asymmetry. Helsley and Strange (2000) analyzed models where the public sector actively competes with the private sector in services such as garbage collection.
2. In one type of model, decision makers of hospitals (physicians) maximize their own, rather than shareholder, incomes (Pauly and Redisch 1973). In others, managers or trustees maximize dividends that they receive "in-kind." In this case, if cooperation between claimants is possible, the profit-maximizing price and location of nonprofits mirror those of for-profits. In a third class of models, nonprofits maximize output, quality, or some type of combination. In this case, nonprofit location and pricing decisions differ from those of for-profits. In the model presented in this article, nonprofits maximize output.
3. Prices are fixed in this model.
4. Consumers would split equally among the three facilities.
5. Firms could receive a subsidy.
6. Recall that $x_g = (\ell/6, 5\ell/6)$ in the planner's case.
7. Oates (1967) provided empirical evidence that locating within a district with good schools raises property values. As districts are combined and/or voucher systems are introduced, the rent gradient should change.

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