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Sports Facilities, Agglomeration, and Urban Redevelopment

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Abstract

We develop a monopolistic competition model of urban service consumption and production that includes spatial structure and property values. The model shows that the introduction of a new professional sports facility and team generates agglomeration effects that change the mix of services and property values, and increases local welfare, part of which is transferred to the team as subsidies for the construction of the facility. The distributional consequences of the new facility and the implications of property tax based financing for the subsidy are analyzed.

JEL Codes: R13, R58, H71, L83

Key Words: Agglomeration effects, sports facilities, subsidies

1 Introduction

Professional sports facilities occupy an important place in the fabric of modern urban society. This importance stems from the iconic nature of these facilities, consumers' interest in the events that take place in them, growing interest in professional sport in society, the rapidly expanding media coverage of professional sporting events, and the passionate emotional relationship between fans and the professional sports teams that play in these facilities. In Chicago, the role occupied by Wrigley Field differs significantly from the role occupied by the Wrigley Building. Professional sports facilities make important contributions to two critical urban amenities identified by Glaeser et al. (2001) as drivers of urban growth: a rich variety of consumer goods and aesthetics related to the physical setting.

In addition, new professional sports facilities have a large and increasing economic significance in cites around the world. Zimbalist and Long (2006) report that 234 new professional sports stadiums and arenas were built in the US over the period 1950 to 2010, including projects under way at the time the paper was published, and estimate the total cost of these facilities at over \$59 billion in 2006 dollars. More than half of these new facilities, accounting for more than 75% of the total construction spending, were built after 1990. Zimbalist and Long (2006) also estimate that the value of state and local government subsidies for these facilities was \$36.3 billion dollars, or 61.5% of total spending. The economic activity that takes place in these stadiums and arenas is entirely private enterprize. Professional sports teams are privately held profit maximizing firms, and the revenues generated from professional sporting events are split between team owners and employees, primarily players. Very few private, profit generating urban economic activity receive this sort of subsidy for capital spending; imagine if more than 60% of the costs of building new hotels in cities was paid for with public funds.

Public subsidies on this scale require some justification, especially given that the owners of many professional sports teams are billionaires (Seattle Seahawks and Portland Trailblazers owner Paul Allen has estimated personal wealth of \$13.5 billion, and a number of other team owners have reported net personal wealth in the billions) and many players earn millions of dollars each year. The primary beneficiaries of these subsidies appear to have access to sufficient financial resources to pay for their own new facilities. Initially, tangible labor market and fiscal benefits, in the form of new jobs, higher income, and increased tax revenues were used to justify subsidies for the construction of professional sports facilities by proponents of these subsidies. However, a significant body of academic research refuted claims of significant economic benefits of these kind flowing from professional sports.[1]

Recently, the justification for subsidies for professional sports facility construction changed. Instead of tangible labor market and fiscal benefits, proponents of subsidies for the construction of professional sports facilities now tout urban redevelopment as a key justification. Rosentraub (2009) documents the role played by a select group of professional sports facilities in the revitalization of declining urban cores in several North American cities, suggesting that urban revitalization might be an important justification for subsidies.[2]

This paper develops a spatial model to analyze the impact of professional sports facilities on urban redevelopment and local welfare in the presence of agglomeration in service provision, and investigates the negotiation between professional sports leagues and cities to understand the size and redistribution effects of the subsidy. The model contributes to the literature of urban economics and sports economics. It provides a framework for understanding professional sports facilities as an urban redevelopment tool and interpreting results in the large empirical literature on the economic impact of professional sports teams, which contains little evidence supporting the idea that professional sports can increase local income or employment, considerable evidence that the introduction of a professional sports team can affect the composition of services provided in a city, and growing evidence that professional sports teams and facilities affect nearby property values. The model highlights the important role played by the monopoly power of professional sports leagues, generated by explicit and implicit exemption from antitrust law as a matter of long-standing public policy in North America. It helps to explain why local decision makers continue to provide large subsidies for the construction of professional sports facilities in North America, despite the lack of evidence that professional sports can generate significant tangible labor market and fiscal benefits for the local economy.

The spatial model of service production and consumption developed in Section 3 includes consumers with preferences for variety in the consumption of both traded goods and non-traded services, building on a model of consumer behavior developed by Spence (1976) and Dixit and Stiglitz (1977) and agglomeration effects in spatial monopolistic competition model discussed by Fujita (1988). The long-run equilibrium with free entry of service firms may under-supply services that are less substitutable by traded goods but

[1] Coates and Humphreys (2008) survey this literature and conclude that an overwhelming amount of academic research over the past 30 years refutes claims that professional sports generate tangible net labor market and fiscal benefits in cities.

[2] The decline of the core of many cities in North America has been extensively documented. Glaeser and Shapiro (2001) document this decline in many large cities over the past 50 years, and identify factors associated with broad trends in urban growth and decline across cities.

have high fixed cost or that are provided by suppliers who have market power. Professional sports games have all the three characteristics that may lead to under-provision.

In Section 4, we formally introduce professional sports games into the model as a less sustitutable and high fixed-cost service. We analyze two scenarios: one with the professional sports facility locating at the existing service consumption center, where economic agglomeration already happens, and the other with the professional sports facility locating at a place with low property value, where redevelopment may be perceived by the city government as necessary. We focus on the latter scenario that the government uses the professional sports facility to generate agglomeration economies and revitalize the neighborhood of interest. The government plays the coordinator role to overcome spatial inertia as land developers in the work of Rauch (1993).

Glaeser and Gottlieb (2009) identify research into the sources and nature of agglomeration economies as an important future research area. In this paper, agglomeration economies arise from a specific source – the ability of professional sports facilities to attract large numbers of consumers to a specific location on certain dates, which emphasizes the low substitutability of live professional sports with traded goods and other services. The agglomeration effect of professional sports facilities may lead to the emerging of a new service consumption center — an "arena district." We analyze the impact of the "arena district" on the existing consumption center, property values, and city-wide welfare in detail. A general conclusion is that an "arena district" will increase city-wide welfare before the transfer between the city and the team, which means the city has an incentive to provide subsidies in order to host a professional sports team.[3]

Section 5 analyzes how the market power of professional sports leagues affects the size of subsidies. We describe a game in which a monopoly sports league and two cities compete for one expansion team. When the two cities have similar economic conditions (average income in the model), the league may extract almost all the welfare gain from the host city.[4] Section 6 discusses the redistribution effect of the sports facility and the "arena district" taking into account the financing of the subsidy.

[3]The city-wide welfare analysis in our paper is related to Henkel et al. (2000) and Tabuchi (2009), which investigate the welfare consequences of new marketplaces organized by coalitions of firms.

[4]Note that we do not adopt a mechanism design approach in this paper. We undertake a positive analysis of the process through which monopoly sports leagues determine the number and location of professional sports teams, cities compete for the right to host professional sports teams, and local governments subsidize the construction of professional sports facilities.

2 Sports Facilities and Urban Redevelopment

Glaeser (1998) discussed the economic problems inherent in urbanization, including urban decline, and identified a number of factors that could be expected to revitalize cities. He emphasized the role played by agglomerative forces, including non-work related agglomerative benefits, in the revitalization of cities. Glaeser and Gottlieb (2006) pointed out the importance of the large variety of consumer services available in cities, including entertainment services, in explaining the resurgence of cities that began in about 1980. Glaeser et al. (2001) investigated the role played by consumer amenities in explaining US urban growth since 1977, and identified the presence of live performance venues and restaurants as key consumer amenities. Professional sports are one type of service that could be included among the factors identified as driving urban revitalization in this line of research. Live professional sports at the highest level – the "big four" professional football, basketball, baseball and ice hockey leagues in North America – is provided almost exclusively in large cities. With the exception of Green Bay, Wisconsin, home of the Green Bay Packers, 2010 population 306,241, 153rd largest Metropolitan Statistical Area (MSA) in the US, all of the US MSAs that are home to professional sports teams in these four leagues have populations of at least 1,000,000 persons and are among the 50 largest cities in the United States. Sport is one of the most visible consumer entertainment services available in industrialized countries; most newspapers have a sports section and local news broadcasts have a sports segment that devote considerable attention to professional sporting events, and many cities derive part of their civic identity from the local professional sports team. Proximity to a professional sports team – living close enough to a professional sports facility – appears to be a potential urban entertainment amenity that drives urban growth.

Given these characteristics of professional sport, and the large subsidies provided for the construction of professional sports facilities, it is not surprising that professional sports are increasingly identified as a key element of many urban revitalization plans. Rosentraub (2009) investigated the role played by professional sports facilities and teams in urban revitalization projects in several US cities over the past decade. The key feature of sports-led urban redevelopment projects that emerge from these case studies is the related development that takes place around urban sports facilities, and the way in which the facilities are integrated into the urban tapestry. In the context of the resurgent consumer city described by Glaeser et al. (2001), Rosentraub (2009) argues that professional sports facilities represent one specific entertainment service that the local government can promote, through specific policies, to revitalize a specific urban area. Because most sports-led urban revitalization projects are relatively new, and the effects of urban revitalization projects take a long time to appear, it will likely be some time before empirical evidence about the effectiveness of these policies can be developed. A model that includes the production and consumption of services, the spatial urban structure, and the presence of professional sports facilities with the potential to generate agglomeration effects will provide a context for evaluating the claims of proponents of sports-led urban revitalization projects and to better understand the role played by professional sports teams in the urban economy.

3 A Spatial Model of Service Production and Consumption

We initially develop a model of the production and consumption of a traded good and services, and the determination of housing values, in an urban area. The model includes consumers who derive utility from the consumption of both traded goods and non-traded services and also purchase housing. Goods can be purchased and consumed without travel, but consumption of services requires travel; the model also incorporates spatial aspects of the provision and purchase of services.

3.1 Urban Spatial Structure and Consumers

Consider a circular city that initially contains a consumption center where a number of non-traded services $S = (s_1, s_2, s_3, \ldots, s_n)$ are produced. Housing is assumed to be a homogeneous composite commodity composed of land and structures, and is uniformly distributed along a circle which has circumference N. This circle represents the residential zones of the city. Residents have to travel to the consumption center to consume services. The consumption center is treated as a point on this circle.[5] For convenience, the consumption center is taken as the origin and $z \in [0, \frac{N}{2}]$ is the distance from the consumption center to any specific residential property on the circle. Residents of the city earn identical income y, which can be interpreted as the average per capita income in the city.

We model the consumption and provision of services using the approach developed in Dixit and Stiglitz (1977). Consumers have identical preferences for the consumption of

[5] Treating the consumption center as a point means that commercial zones will not push the boundary of residential zones.

a traded good x, housing services (h), and n non-traded services, again denoted by the vector $S = (s_1, s_2, s_3, \ldots, s_n)$. These preferences are described by a constant elasticity of substitution (CES) utility function:

$$u\left(h, x, \sum_{j=1}^{n} a_j s_j^{\rho}\right) = h\left[x^{\rho} + \sum_{j=1}^{n} a_j s_j^{\rho}\right]^{1/\rho} \tag{1}$$

with parameters $0 < \rho < 1$ and $a_j \geqslant 0$. ρ reflects the marginal rate of substitution. a_j captures the marginal utility of service j, allows for heterogeneity in services, and also differentiates services in terms of their substitutability in consumption with the traded good x. Spence (1976) investigated the properties of this type of CES utility function in a similar context. A large a_j means that service j is less substitutable for the traded good x. This utility function also embodies the idea that consumers have a taste for diversity in the consumption of services. For simplicity, normalize the consumption of housing services to $h = 1$; each individual consumes one unit of housing services.

To consume services, residents must travel to the location where the services are produced, the consumption center. Travel cost is assumed to be linearly increasing with distance to the consumption center and travel cost per unit of distance is t. For residents who travel to the consumption center, the budget constraint is

$$p_x x + \sum_{j=1}^{n} p_j s_j = y - tz - p^h(z), \tag{2}$$

where $p_j > 0$ is the price of service j, and $p_x > 0$ is the price of the traded good x, which is determined in a national or international market and is assumed to be exogenous and not affected by changes taking place in the city. Without loss of generality, we can normalize the price of the traded good, p_x, to be equal to one to abstract from any decisions related to the production or consumption of the traded good. $p^h(z) \geqslant 0$ is the price of housing which depends on the distance z from the consumption center to any dwelling; housing prices vary with distance from the consumption center. Consumers can either travel to the consumption center and consume both services and the traded good or not travel and consume only the traded good. This decision will depend on travel costs and where a consumer decides to live, which depends on the price of housing services. Consumers choose a quantity of the traded good, a vector of quantities of services, and a dwelling located z distance from the consumption center to maximize utility, subject to the budget constraint, Equation (2).

Let the price of a dwelling located infinitely close to the consumption center, at $z = 0$, be p_0^h. The housing market is assumed to be in equilibrium. In equilibrium, consumers living different distances from the consumption center will have identical levels of utility regardless of the location of their residence, which implies that housing prices will adjust in equilibrium such that spending on the traded good and non-traded services is equal for all residents who travel to the consumption center regardless of where they live in the city. In other words

$$y - tz - p^h(z) = y - p_0^h.$$

We restrict the housing price to be non-negative. This is simply a normalization. We can set the minimum housing price to any positive number without loss of generality. In equilibrium, the housing price as a function of distance z from the consumption center is

$$p^h(z) = p_0^h - tz \geqslant 0 \tag{3}$$

a function of the maximum housing price, transportation cost per unit of distance, and distance from the consumption center. In other words, a standard housing price gradient exists in the city where housing prices decline monotonically with distance from the consumption center.

Abstracting momentarily from housing decisions, consumers choose x and $S = (s_1, s_2, s_3, \ldots, s_n)$ to maximize utility, taking prices $p_s = (p_1, p_2, ..., p_n)$, $p^h(z)$, and transportation costs, t, as given. For simplicity, redefine the utility function parameter σ as $\sigma \equiv \frac{1}{1-\rho} > 1$. Individual's demand for service j is

$$s_j = \frac{a_j^\sigma (y - p_0^h)}{(p_j)^\sigma P^{1-\sigma}}. \tag{4}$$

where $P = \left[1 + \sum_{i=1}^{n} a_i^\sigma \left(p_i\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$ is a price index reflecting a weighted average of the prices of the traded good and the services produced in the city. Equation (4) is an inverse demand function with the standard interpretation. Demand for service j rises with income y, falls with own price p_j and the local price level P. The larger a_j, the less substitutable is service j for the traded good and the higher the (inverse) demand for service j.

We can now characterize residents' decisions about the consumption of services and travel to the consumption center. Residents who consume services live a distance from the consumption center bounded by $z \leq \frac{p_0^h}{t}$. Recall the size of the city is N, so $z \in [0, \frac{N}{2}]$. If $\frac{p_0^h}{t} \geqslant \frac{N}{2}$, then all residents of the city travel to the consumption center. If $\frac{p_0^h}{t} < \frac{N}{2}$, then not all residents travel to the consumption center. In this case, the consumption center will have an impact zone in which the presence of the consumption center affects housing values. Within this impact zone, defined by $z \in [0, \frac{p_0^h}{t}]$, all residents travel to the consumption center and the price of a dwelling located z from the consumption center is $p^h(z) = p_0^h - tz > 0$. Outside of the impact zone ($z \in (\frac{p_0^h}{t}, \frac{N}{2}]$), residents do not travel to the consumption center and housing prices are $p^h(z) = 0$. Again, recall that this normalization was made for simplicity; we could reformulate the model to make this some positive value. In this paper, we focus on the case where $\frac{p_0^h}{t} < \frac{N}{2}$ and not all residents travel to the consumption center, as it is more general and also may be a better description of the actual provision of services in cities.

The indirect utility of consumers who live in the impact zone of the consumption center ($z \in [0, \frac{p_0^h}{t}]$)

$$U_I = \frac{y - p_0^h}{P}.$$

A derivation for this expression can be found in Appendix (A.1.) Consumers who live outside of the impact zone pay a relatively small amount for housing, $p^h(z) = 0$, compared to residents of the impact zone, and spend all their income y on the traded good x. The indirect utility for consumers outside the impact zone is

$$U_O = x = \frac{y}{p_x} = y \ \forall z \in \left(\frac{p_0^h}{t}, \frac{N}{2}\right].$$

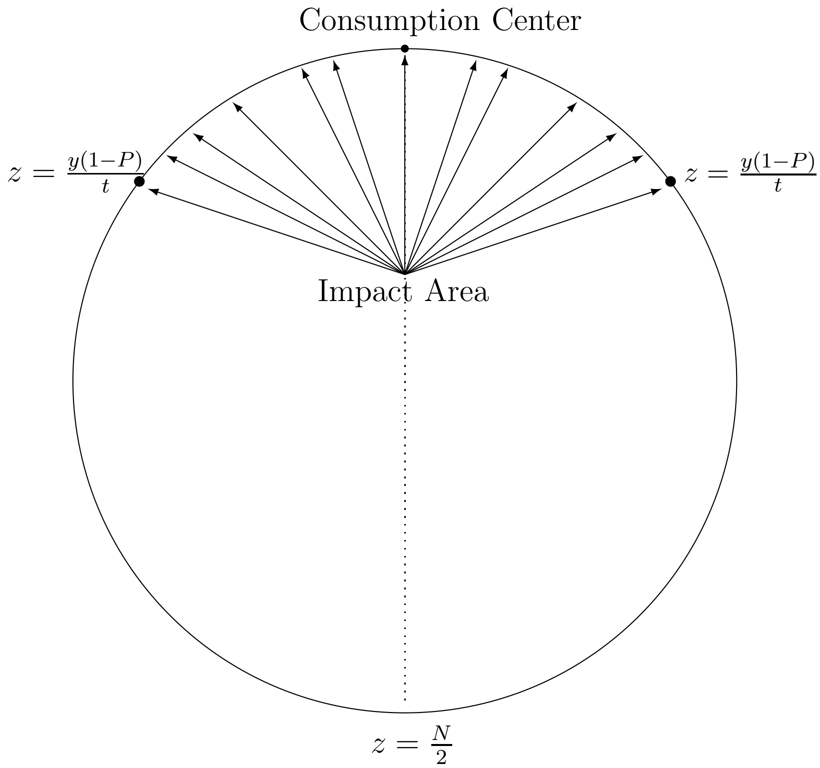
Since all city residents have identical preferences, in equilibrium they should get the same level of utility no matter where they live, i.e. $U_0 = U_I = U_O = y$. From $\frac{y - p_0^h}{P} = y$, we can solve for the housing price at $z = 0$,

$$p_0^h = y(1 - P).$$

which is the maximum housing price in the impact zone.

Figure 1 shows equilibrium in the model in terms of the effect of the consumption on housing prices. The city is represented by a circle with circumference N and z indicates distance from the consumption center, which is identified by the point at the top of the circle. Housing prices decline with distance from the consumption center; this is the standard prediction that emerges from the textbook "bid rent theory" from urban economics when travel is costly, except that travel to the consumption center generates the rent gradient in this case. The maximum distance from the consumption center is $\frac{N}{2}$ at the bottom of the circle.

Figure 1: Housing Prices and Distance to the Consumption Center



The impact area is defined by a distance from the consumption center $z = \frac{y(1-P)}{t}$ which depends on income, the aggregate price level, and transportation costs. Higher income per capita is associated with larger impact areas since higher income allows consumers to travel farther to the consumption center; higher transportation costs are associated with smaller impact areas. Inside the impact area consumers travel to the consumption center and housing prices are affected by the proximity of the consumption center. Outside the impact area consumers do not travel to the consumption center and housing prices are not affected.

3.2 The Provision of Services

Note that n different services are supplied at the consumption center. Assume that the production of service j has a fixed cost f_j and a constant marginal cost c_j. Firm j will choose a price p_j for its output to maximize profit

$$\pi_j = p_j q_j - c_j q_j - f_j$$

where q_j is the quantity of service j provided.

Since all residents in the impact zone travel to the consumption center and their consumption of service j is determined by Equation (4), city-wide aggregate demand for service j is

$$q_j = 2\frac{p_0^h}{t}s_j = \frac{2a_j^\sigma p_0^h(y - p_0^h)}{t(p_j)^\sigma P^{1-\sigma}} = \frac{2a_j^\sigma y^2(1 - P)P^\sigma}{tp_j{}^\sigma}.$$

Assume that services are produced under monopolistic competition. Firm j takes the overall local price level P as given and chooses p_j to maximize profits. Note that monopolistic competition also implies that an individual firm takes the size of the impact zone $z \in [0, \frac{y(1-P)}{t}]$ of the consumption center as given. The profit maximizing price set by a service providing firm is

$$p_j = \frac{\sigma}{\sigma - 1}c_j.$$

which is a markup over marginal cost where the markup depends on the substitution parameter. For simplicity, assume the marginal cost of production is the same for all services provided in the city, so that $c_j = c$ for all $j = 1, ..., n$. Therefore, firms charge identical prices, $p_j = p = \frac{\sigma}{\sigma-1}c$ and the local price level of services, P, becomes

$$P = \left[1 + p^{1-\sigma}\sum_{i=1}^{n} a_i^\sigma\right]^{\frac{1}{1-\sigma}}. \tag{5}$$

From Equation (5), as more services are provided at the consumption center, n increases and P decreases. The increased provision of a variety of services reduces the local price of services; this is referred to as the "agglomeration effect." Dixit and Stiglitz (1977) demonstrated the existence of this effect in a more general setting. Under these simplifying assumptions, demand for service j becomes

$$q_j = \frac{2a_j^\sigma y^2(1 - P)P^\sigma}{tp^\sigma}$$

and the maximum profit earned by firm j is

$$\Pi_j = \frac{2a_j^\sigma y^2(1 - P)P^\sigma}{\sigma tp^{\sigma-1}} - f_j, \tag{6}$$

a function of local income per capita, the aggregate local price level and own price.

Entry and exit of service providing firms is an important feature in this setting. Long-run equilibrium in the provision of services in the city can be defined by the standard break-even condition, since only profitable service producing firms or firms earning zero economic profits will operate in the city in the long run. Service production in the city will be in long-run equilibrium with free entry, and service j will be provided to residents of the city, if $\Pi_j \geqslant 0$. We next characterize the nature of entry into the services market.

3.3 Long Run Equilibrium in Service Provision with Free Entry

A long run equilibrium with free entry for this city can be defined as a number of services n_1 provided at the consumption center, a set of service prices $\{p_{1,}\ p_{2,}\ ...,p_{n_1}\}$, a distribution of housing prices $p(z)$ where $z \in [0, \frac{N}{2}]$, a cut-off $\frac{p_0^h}{t}$ for the impact zone of the consumption center, and a consumption choice set for consumers $\{x,\ s_{1,}\ s_{2,}\ ...,s_{n_1}\}$, such that: 1) consumers maximize their utility subject to their budget constraints and get the same level of utility; 2) service producers maximize profits and make non-negative profits; and 3) the housing market and service markets clear.

There are two possible equilibria: one with no services provided at the consumption center ($n_1 = 0$), and one with a positive number of services ($n_1 > 0$) provided at the consumption center. This can be shown by examining the relationship between Π_j and P. Differentiate Π_j with respect to P

$$\frac{\partial \Pi_j}{\partial P} = \frac{2a_j^\sigma y^2 P^{\sigma-1}}{\sigma t p^{\sigma-1}} \left[\sigma - (\sigma+1)P\right].$$

Profits earned by service producing firms are a non-linear function of the local price level. When the local price level is relatively low and $P \in [0, \frac{\sigma}{\sigma+1}]$, $\frac{\partial \Pi_j}{\partial P} \geqslant 0$ and profits increase as local prices increase in long-run equilibrium. When the local price level is relatively high, and $P \in (\frac{\sigma}{\sigma+1}, 1]$, $\frac{\partial \Pi_j}{\partial P} < 0$ and profits decline in long-run equilibrium as the local service price level increases. Recall from Equation (5) that when more varieties of services are provided at the consumption center, the local price level P declines. This non-linear relationship arises because service production under monopolistic competition at the consumption center are subject to both an agglomeration effect and a competition effect. When no services are produced at the consumption center, $P = 1$, Π_j increases with the introduction of new services because the agglomeration effect dominates the competition effect. When enough varieties of services are produced at the consumption center, increasing the number of varieties provided at the consumption center pushes P into the interval $[0, \frac{\sigma}{\sigma+1}]$, and Π_j starts to decline because the competition effect dominates the agglomeration effect.

The equilibrium with no service provision at the consumption center is the one that fails to achieve the necessary agglomeration effects to generate enough consumer traffic and revenue to cover the fixed cost of producing services. If this is the initial city equilibrium, then any policy intervention that helps to mitigate this inefficient outcome will be welfare enhancing for the city. This case, however, is less relevant in this context because the cities of interest usually have a pre-existing consumption center before they pursue a sports-led urban redevelopment program. For this reason, we assume the long-run equilibrium in the city is the one with $n_1 > 0$ services provided at the consumption center, which means that $P < \frac{\sigma}{\sigma+1}$ and the marginal service firm operating at the consumption center makes zero profit.

Services are not completely symmetric in this model, so another question is what kind of services will be provided at the consumption center in long-run equilibrium. Service j will be provided if $\Pi_j \geqslant 0$, i.e.,

$$\frac{f_j}{a_j^\sigma} \leq \frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}. \tag{7}$$

In order to characterize the services provided, first rank services in terms of the ratio of the fixed cost of production to the substitutability with the traded good, $\frac{f_j}{a_j^\sigma}$, from smallest to largest, so that

$$\frac{f_1}{a_1^\sigma} \leq \frac{f_2}{a_2^\sigma} \leq ... \leq \frac{f_n}{a_n^\sigma}.$$

Services will be introduced at the consumption center in this order. With the introduction of more services, $\frac{f_j}{a_j^\sigma}$ increases and P decreases. As P declines from 1 to $\frac{\sigma}{\sigma+1}$, $\frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}$ increases, providing an incentive for more varieties of services to enter the consumption center and further decreasing P. Any further decrease of P from $\frac{\sigma}{\sigma+1}$ to 0 due to the introduction of more services will drive down $\frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}$. As more and more varieties of services enter the consumption center, the left side of Equation (7) increases and the right side of Equation (7) eventually decreases as the competition effect dominates the agglomeration effect. At some point, an entering service producing firm just breaks even. If the last firm is n_1, then

$$\frac{f_{n_1}}{a_{n_1}^\sigma} = \frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}.$$

All the service producing firms with $j < n_1$ make positive profits because $\frac{f_j}{a_j^\sigma} \leq \frac{f_{n_1}}{a_{n_1}^\sigma} =$

$\frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}$. All the service producing firms with $j > n_1$ will have $\frac{f_j}{a_j^\sigma} > \frac{2y^2(1-P)P^\sigma}{\sigma t p^{\sigma-1}}$, i.e., $\Pi_j < 0$. Therefore, no potential service producing entrant could make a profit, and none will enter.

Next, consider total welfare in the city. In equilibrium, the welfare of consumers is total income in the city, $NU_0 = Ny$; the total profits of the service providers can be found by aggregation, $\sum_{j=1}^{n_1}\Pi_j$, and the aggregate city-level housing value is

$$2\int_0^{N/2} p(z)dz = 2\int_0^{\frac{p_0^h}{t}} (p_0^h - tz)dz = \frac{y^2(1-P)^2}{t}.$$

The total welfare of the city is simply the sum of these three values

$$\begin{aligned} TW_0 &= NU_0 + \sum_{j=1}^{n_1}\Pi_j + 2\int_0^{N/2} p(z)dz \qquad (8) \\ &= Ny + \sum_{j=1}^{n_1}\left[\frac{2Ny^2(1-P)P^\sigma a_j^\sigma}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P)^2}{t}. \end{aligned}$$

And recall that $P \geqslant 1 - \frac{Nt}{2y}$.

Note that the varieties of services provided in this equilibrium may not be the same as the varieties that are socially optimal for the city. Appendix A.2 shows that city welfare

$$TW = NU + \sum_{j=1}^{n}\Pi_j + 2\int_0^{N/2} p(z)dz$$

improves when the price index P declines. Introducing a service n_1+1 to the consumption center may be welfare improving for the city because the increase in aggregate property value $\frac{y^2(1-P)^2}{t}$, the third term in equation (8), can increase enough to offset the negative impact of this entry on the profits earned by service providers, the second term in equation (8). Compared to the outcome desired by a city planner, a monopolistically competitive services market may be biased against services with large fixed costs, which will not enter in equilibrium. Spence (1976) find similar results in a more general setting.

Also we assume that service providers will enter and supply a given service if they make non-negative profits. This assumption may hold for many services but not for all. Professional sports, the focus of this analysis, is one of the exceptions. Professional sports leagues have monopoly power, which allows them to choose the supply of teams to maximize league-wide profits. We cannot expect professional sports leagues to expand into a city just because a team will be able to break even in this city, as expansion reduces the monopoly power of existing teams in the league.

Without any intervention, a city may reach a long-run equilibrium with an under-supply of high-fixed-cost, low-substitutability services or services that are provided by suppliers who have market power. The possible deviation of the market equilibrium from the outcome that would be optimal from the perspective of a city planner suggests that a city planner has the potential to improve the welfare of the city by intervening in the provision of some services. The next section analyzes the provision of professional sports, a high-fixed-cost, low-substitutability service whose provision involves both local governments and professional sports leagues with significant monopoly power.

4 Sports Facilities and Teams

The provision of professional sports is affected by three characteristics that differentiate them from other services. First, in order to host a professional sports team, a stadium or arena that meets the standards of professional sports leagues must exist in a city. The construction of new sports facilities involves significant costs, including land, infrastructure like roads, utilities and sewerage, and the structure. Siegfried and Zimbalist (2000) estimate that the average cost of professional sports facility construction in US was $200 million over the period 1990 to 1998. Long (2005) showed that many public sports facility construction cost estimates omitted important factors like capital improvements, municipal services, and forgone property taxes and estimated that the total costs exceeded the costs reported by Siegfried and Zimbalist (2000) by at least 40%. Zimbalist and Long (2006) estimated that the average cost of a new sports facility over the period 2000-2006 was nearly $400 million. Several recent NFL stadium construction projects, for example the new stadium built for the Dallas Cowboys and the new stadium jointly used by the New York Jets and Giants and the new Yankee Stadium in New York, cost in excess of one billion dollars to build.

Second, attendance at live professional sports cannot be easily substituted by the consumption of traded goods. For most consumers, the difference in marginal utility generated by attending a professional sporting event and watching the game at home is larger than the difference between drinking a glass of wine at a local bar and drinking a glass of wine at home. In other words, live attendance at a professional sporting events can be thought of as an experience good (Shapiro (1983)). The substitutability of attending a professional game and traded goods is probably low because of the experiential aspect of attending games and the presence of joint consumption with other fans.

Third, professional sports leagues, the suppliers of professional sports teams, have significant market power relative to individual cities. Leagues choose the number of teams to maximize league-wide profits and usually make positive profits in the long run. Territorial agreements guarantee that each team will be a monopolist in its local market, with a few notable exceptions like New York in the NFL and MLB and Chicago in MLB.

We formally model these three characteristics of professional sports and investigate how government intervention, in the form of adding a professional sports team and building a publicly subsidized facility, will affect the overall and welfare in the city and the distribution of welfare. Assume that the provision of professional sports entails a fixed cost f_{pf} that is much larger than the fixed cost of other services provided in the city, i.e., $f_{ps} > f_j$, $\forall j = 1, 2, ..., n_1$; and that the substitutability of attending a live game and the consumption of the traded good is much lower than for other services, i.e., $a_{ps} > a_j$, $\forall j = 1, 2, ..., n_1$. The fixed cost is higher because of the facility cost and because professional sports teams have fixed roster sizes and the salaries of professional athletes is high. Consider a city that is in a long-run equilibrium with no professional sports team. In this long-run equilibrium, the profits earned by a professional sports team entering the city

$$\Pi_{ps} = \frac{2Ny^2(1-P)P^{\sigma}a_{ps}^{\sigma}}{\sigma t p^{\sigma-1}} - f_{ps}$$

where the price level including the professional sports team is

$$P = \left[1 + p^{1-\sigma}(\sum_{i=1}^{n_1} a_i^{\sigma} + a_{ps})\right]^{\frac{1}{1-\sigma}}$$

may be positive.

A city planner considers attracting a professional sports team through some government intervention like building a new facility that meets the league's requirements. The city planner's problem is two-fold: whether to attract a team through a public subsidy to the team and where in the city to locate the sports facility. We first consider the locational choice, and then the subsidy decision. A new professional sports facility can be located an existing consumption center or at a location in the city away from the existing consumption center.

4.1 A Professional Sports Facility at the Existing Consumption Center

Suppose the city planner chooses to locate the sports facility at the original consumption center of the city, then the newly available service — live professional sports games — will increase the impact zone of the consumption center and reduce the consumption of other services for consumers who are in the impact zone before the city intervention.

The profits of service j, with the presence of professional sports at the consumption center, will be

$$\Pi'_j = \frac{2a_j^\sigma y^2(1-P')P'^\sigma}{\sigma t p^{\sigma-1}} - f_j,$$

where

$$P' = \left[1 + p^{1-\sigma}(\sum_{i=1}^{n} a_i^\sigma + a_{ps}^\sigma)\right]^{\frac{1}{1-\sigma}} \leq P. \tag{9}$$

The entry of the team decreases the local price index because of the provision of additional services.

Consider the effect of the entry of a professional sports team on the marginal service supplier, n_1, which just breaks even before a professional sports team enters the consumption center. The marginal service provider n_1 exits because it earns negative profits ($\Pi'_{n_1} < \Pi_{n_1} = 0$) after the entry of the professional sports team. With the presence of the professional sports team at the consumption center, the number of services other than the professional sports, denoted by n_2, will be smaller than the number of services provided before the entry of a professional sports team, n_1.

To see this, again rank the services provided in terms of $\frac{f_j}{a_j^\sigma}$, from smallest to largest, so that

$$\frac{f_1}{a_1^\sigma} \leq \frac{f_2}{a_2^\sigma} \leq ... \leq \frac{f_n}{a_n^\sigma}.$$

Services n_1, $n_1 - 1$, ..., will exit the market in that order. With the exit of these services, $\frac{f_j}{a_j^\sigma}$ decreases and the price index increases, and $\frac{2y^2(1-P')P'^\sigma}{\sigma t p^{\sigma-1}}$ increases. The marginal service in the new equilibrium will have

$$\frac{f_{n_2}}{a_{n_2}^\sigma} = \frac{2y^2(1-P')P'^\sigma}{\sigma t p^{\sigma-1}},$$

where P' is defined by Equation (9). Service $j < n_2$ will make non-negative profits because

$$\frac{f_j}{a_j^\sigma} \leq \frac{f_{n_2}}{a_{n_2}^\sigma} = \frac{2y^2(1-P')P'^\sigma}{\sigma t p^{\sigma-1}}.$$

The new equilibrium with a sports team at the consumption center is defined by a number of services n_2+1 at the consumption center, a set of service prices $\{p_1, p_2, ..., p_{n_2}, p_{ps}\}$, a distribution of housing price $p^{h\prime}(z)$ where $z \in [0, \frac{N}{2}]$, a cut-off $\frac{p_0^{h\prime}}{t}$ for the impact zone of the consumption center, and a consumption choice of consumers $\{x', s_1', s_2', ..., s_{n_2}', s_{ps}'\}$, such that 1) consumers maximize their utility subject to their budget constraint and get the same level of utility; 2) service producers maximize profits and make non-negative profits; 3) the housing market and service markets clear.

We can easily compare the pre-sports team equilibrium to the equilibrium after a new team enters. The local price index is weakly lower $P' \leq P$. A smaller number of services are provided ($n_2 < n_1$). Profits for the n_2 services that survived the entry of the professional sports team is weakly smaller $\Pi_j' \leq \Pi_j$. The size of the impact zone of the consumption center is weakly larger $\frac{p_0^{h\prime}}{t} = \frac{y(1-P')}{t} \geqslant p_0^h = y(1-P)$. Housing values in the new impact zone are higher $p'(z) = p_0^{h'} - tz \geqslant p(z) = p_0^h - tz$. Consumers' utility remains constant at y because the utility gain from a lower price index is capitalized into the housing value.

In the new equilibrium, the welfare of consumers is $NU_1 = Ny$; total profits of the service providers are $\sum_{j=1}^{n_2} \Pi_j' + \Pi_{ps}'$, and the aggregate city-level housing value is $2\int_0^{N/2} p'(z)dz = \frac{y^2(1-P')^2}{t}$. The total welfare of the city is

$$\begin{aligned}
TW_1 &= NU_1 + (\sum_{j=1}^{n_2} \Pi_j' + \Pi_{ps}') + 2\int_0^{N/2} p'(z)dz \\
&= Ny + \sum_{j=1}^{n_2} \left[\frac{2Ny^2(1-P')P'^\sigma a_j^\sigma}{\sigma t p^{\sigma-1}} - f_j\right] + \left[\frac{2Ny^2(1-P')P'^\sigma a_{ps}^\sigma}{\sigma t p^{\sigma-1}} - f_{ps}\right] + \frac{y^2(1-P')^2}{t}
\end{aligned}$$

Next, consider the change in total welfare in the city net of the profits of the sports team. This change is

$$TW_1 - TW_0 - \Pi_{ps}' = \left[\sum_{j=1}^{n_2}(\Pi_j' - \Pi_j) - \sum_{j=n_2+1}^{n_1} \Pi_j\right] + \left[\frac{y^2(1-P')^2}{t} - \frac{y^2(1-P)^2}{t}\right]. \quad (10)$$

The first term on the right-hand of Equation (10) is the change in profits earned by service suppliers at the consumption center; this term is negative because the entry of the sports team reduces the local price index and reduces profits of all services at the consumption center. The existing evidence about the economic impact of professional sports teams and facilities based on partial equilibrium empirical analysis of local production and employment is consistent with this sign. For example, Coates and Humphreys (1999) find that GDP per capita is slightly lower in cities with professional sports teams than in cities without teams. Coates and Humphreys (2008) survey this literature and conclude that the consensus in the literature is a negative impact on local GDP and employment.

The second term on the right-hand side of Equation (10) is the change in aggregate property value in the city; this term is positive because it reflects the increased consumer surplus from the decrease of the price index due to the entry of the sports team. Appendix A.3 proves that $TW_1 - TW_0 - \Pi'_{ps}$ is positive, suggesting that the increase in the aggregate property value dominates the loss of profits by service suppliers. While an emerging line of research finds a positive relationship between sports facilities and residential housing values, little evidence exists about the size of this increase.

A city planner might consider providing a subsidy to the owner of the sports team because the team will generate a positive externality for the city, but the subsidy to professional sports teams should not exceed $TW_1 - TW_0 - \Pi'_{ps}$ when the professional sports facility locates at the city's existing consumption center.

Locating the professional sports facility at the city's existing consumption center, a place where economic agglomeration of services already happens, ignores a potentially important externality that a professional sports facility can generate. Once a city has attracted a team and built a facility, a stream of consumers will attend games at the facility. The attractiveness of the sports team has the potential to benefit other service providing firms who co-locate close to the new sports facility. These agglomeration effects are widely observed in service industries in cities, for example, small service providing businesses like dry cleaners, copy and printing services, financial service providers agglomerate near department stores and/or grocery store chains in urban areas. The potential agglomeration effects around a new sports facility suggests that the positive externality generated by a new sports facility construction project may extend beyond $TW_1 - TW_0 - \Pi'_{ps}$. The next section investigates the impact of locating the professional sports facility out of the impact zone of the existing consumption center in the city, which is equivalent to the introduction of an "Arena District" in an area of a city in need of revitalization.

4.2 Professional Sports Facilities and "Arena Districts"

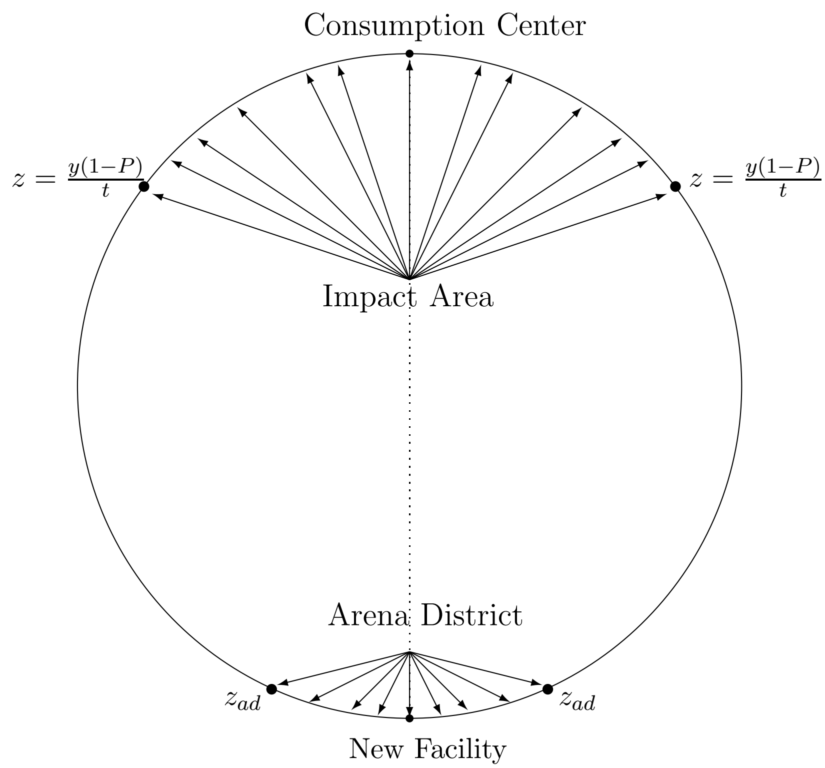
Professional sports are increasingly identified as an important element of urban revitalization projects. Rosentraub (2009) discussed the role played by professional sports facilities and teams in urban revitalization projects in several US cities over the past decade. The key feature of sports-led urban redevelopment projects that emerge from these case studies is the related development that takes place around new urban sports facilities, and the way in which the facilities are integrated into the urban tapestry. In the context of the resurgent consumer city described by Glaeser et al. (2001), Rosentraub (2009) argues that professional sports facilities represent a specific entertainment service that the local government can promote through specific policies to revitalize a specific urban area.

A service that has a high substitutability with the traded good, which by itself would not be able to attract enough consumers to cover fixed costs production costs, may be able to operate profitably in a city if it co-locates with a sports facility. Economic agglomeration involves service-producing firms that cannot be easily substituted for the traded good, generating positive demand externalities for service-producing firms that are more substitutable with traded goods. The attractiveness of live professional sports suggests that the introduction of a new sports facility to a city could form a new service consumption center – an "arena district" – in the city.

Suppose the city planner chooses to locate a new professional sports facility outside of the impact zone of the existing consumption center in the city, in an area that has low property values and where residents do not travel to the consumption center. This often includes downtown areas that suffer from declining of economic activity. "Food deserts" represent one example of these areas (Besharov et al., 2011). Suppose that a new professional sports facility is located at $z = \frac{N}{2}$, as shown on Figure 2. Consumers will travel to the arena district if the marginal utility from attending live games is larger than the travel costs. Because other services have a smaller fixed cost of production than a professional sports team, f_{ps}, the consumer traffic to the sports facility will make some other services profitable if they co-locate with the sports facility. The new "arena district" generates agglomeration effects. Again, rank the services provided in the arena district in terms of $\frac{f_j}{a_j^{\sigma}}$ from smallest to largest. Let n_3 be the marginal service that just breaks even in the arena district.

People who live outside of the impact zone of the city's existing consumption center now have the opportunity to consume services at the arena district. Their utility maximization problem is similar to people who live inside of the impact zone of the city's existing consumption center. Use the same approach used in Section 3, we can derive an

Figure 2: An "Arena District"



expression for the indirect utility for individuals who travel to the arena district

$$U_{ad} = \frac{y - p_{ad}^h}{P_{ad}},$$

where p_{ad}^h is the housing price at the arena district and the price index in the arena district is

$$P_{ad} = \left[1 + p^{1-\sigma}(\sum_{i=1}^{n_3} a_i^\sigma + a_{ps}^\sigma)\right]^{\frac{1}{1-\sigma}}$$

for people who consume services in the arena district.

Clearly, the arena district will have an impact zone and all people who live in the impact zone get the same utility U_{ad}. Therefore, housing prices inside the impact zone of the arena district will be $p(z) = p_{ad}^h - t(\frac{N}{2} - z)$. Again, housing prices are assumed to be non-negative, and we can solve

$$p_{ad}^h - t\left(\frac{N}{2} - z\right) \geqslant 0$$

for the boundary of the arena district's impact zone $z_{ad} = \frac{N}{2} - \frac{p_{ad}^h}{t}$.

If $\frac{p_0^h}{t} \leq \frac{N}{2} - \frac{p_{ad}^h}{t}$, then the impact zone of the arena district does not overlap with the impact zone of the existing consumption center. People who live at $z \leq \frac{p_0^h}{t}$ still travel to the existing consumption center for services and get $U_I = \frac{y-p_0^h}{P}$; People who live at $z \geqslant \frac{N}{2} - \frac{p_{ad}^h}{t}$ trave to the arena district for services and get $U_3 = \frac{y-p_{ad}^h}{P_3}$; People who live at $z \in (\frac{p_0^h}{t}, \frac{N}{2} - \frac{p_{ad}^h}{t})$ still consumes no service and get $U_o = y$. In equilibrium all consumers get the same level of utility, i.e., $\frac{y-p_0^h}{P} = \frac{y-p_{ad}^h}{P_3} = y$, therefore,

$$p_{ad}^h = y(1 - P_{ad}).$$

In this case, the arena district does not compete with the existing consumption center. The arena district is a replica of the service consumption center when the government chooses to construct the arena at the original consumption center. Therefore, $n_3 = n_2$ and $P_{ad} = P'$. Let TW_2 be the new city welfare following the opening of an arena district. The change in welfare net of the profits of the sports team will be

$$TW_2 - TW_0 - \Pi_{ps}^{'} = \sum_{j=1}^{n_2} \Pi_j' + \frac{y^2(1-P')^2}{t} > 0.$$

It contains the profits earned by service providers in the arena district and the increase in housing values in the impact of zone of the arena district. Because of this welfare gain, a city planner may consider providing a subsidy for the construction of a new sports facility that leads to the emergence of an arena district because it generates agglomeration effects that in the form of profitable service providers and increased property value. If the new arena district does not compete with the existing consumption center, the subsidy a city could offer as large as the increase in local welfare $TW_2 - TW_0 - \Pi_{ps}^{'}$.

The case where a new arena district does not affect economic activity at the existing consumption center is a useful abstract. It is more likely to happen in large cities where the urban core is far away from suburban consumption centers. Inner-city residents are usually poor people that rely on public transportation. They were not consumers of suburban consumption centers to begin with because travel to a suburban consumption center is very costly for them. An arena district in these neighborhoods may benefit people living in its impact zone without posing significant competition on existing consumption centers.

It is very likely that a new arena district has an impact area that overlaps with the existing consumption center in a city, which reduces consumer spending at the existing consumption center and negatively affects the profitability and number of varieties of services provided at the existing consumption center. We now analyze this case in detail.

The arena district competes with the existing consumption center if its impact zone overlaps the impact zone of the existing consumption center, i.e., $\frac{N}{2} - \frac{p^h_{ad}}{t} = \frac{N}{2} - \frac{y(1-P_{ad})}{t} < \frac{p^h_0}{t} = \frac{y(1-P)}{t}$. This implies that the marginal service n_1 at the existing consumption center will no longer break even after the creation of the arena district, and will exit because it earns negative profits. Therefore, the price index for people who consume services at the existing consumption center will increase and the impact zone of the existing consumption center will shrink.

A new equilibrium will be reached when the number of services at the existing consumption center, n_5, and the number of services at the arena district, n_4, are such that there is a cut-off point $\widetilde{z}$ such that 1) consumers living in $z \leq \widetilde{z}$ consume services at the existing consumption center and choose $\{x,\ s_{1,}\ s_{2,}\ ...,s_{n_5}\ \}$ to maximize their utility subject to their budget constraint; 2) consumers living in $z > \widetilde{z}$ consume services at the arena district and choose $\{x,\ s_{1,}\ s_{2,}\ ...,s_{n_4}\ ,\ s_{ps}\ \}$ to maximize their utility subject to their budget constraint; 3) all consumers get the same level of utility; 4) service producers maximize profits; 5) service n_5 at the existing consumption center and service n_4 at the arena district make zero profit; 6) the housing market and service markets clear.

The cut-off $\widetilde{z}$ is determined in the housing market where

$$p^h(\widetilde{z}) = p^h_0 - t\widetilde{z} = p^h_{ad} - t\left(\frac{N}{2} - \widetilde{z}\right).$$

Define equilibrium price levels for the arena district P_4 and the existing consumption center P_5 by $P_4 = \left[1 + p^{1-\sigma}(\sum_{i=1}^{n_4} a_i^\sigma + a_{ps}^\sigma)\right]^{\frac{1}{1-\sigma}}$ and $P_5 = \left[1 + p^{1-\sigma}\sum_{i=1}^{n_5} a_i^\sigma\right]^{\frac{1}{1-\sigma}}$. Substitute $p^h_{ad} = y(1 - P_4)$ and $p^h_0 = y(1 - P_5)$, resulting in

$$y(1 - P_5) - t\widetilde{z} = y(1 - P_4) - t\left(\frac{N}{2} - \widetilde{z}\right). \tag{11}$$

From Equation (11), we can solve for the cut-off

$$\widetilde{z} = \frac{N}{4} + \frac{y(P_4 - P_5)}{2t}.$$

Because the creation of the arena district reduced the boundary of the existing consumption center's impact zone

$$\widetilde{z} = \frac{N}{4} + \frac{y(P_4 - P_5)}{2t} < \frac{y(1-P)}{t}.$$

In the new equilibrium with an arena district, the welfare of consumers is still Ny because housing values will adjust to make consumers just as well off as before; total profits of the service providers in the city are $\sum_{j=1}^{n_5} \Pi_j^{cc} + \sum_{j=1}^{n_4} \Pi_j^{ad} + \Pi_{ps}^{ad}$, and the aggregate city-wide housing value equals

$$2\int_0^{\widetilde{z}} (p_0^h - tz)dz + 2\int_{\widetilde{z}}^{N/2} [p_{ad}^h - t(\frac{N}{2} - z)]dz = 2t\left[\frac{N}{4} + \frac{y(P_4 - P_5)}{2t}\right]^2 + [y(1-P_4)]\, N - \frac{tN^2}{4}.$$

Let TW_3 be the new level of total welfare in the city after the introduction of an arena district with an impact zone that overlaps with the existing consumption center. The change in local welfare net of the profits of the sports team will be

$$\begin{aligned} TW_3 - TW_0 - \Pi_{ps}^{ad} = &\left[\sum_{j=1}^{n_5} \Pi_j^{cc} + \sum_{j=1}^{n_4} \Pi_j^{ad} - \sum_{j=1}^{n_1} \Pi_j\right] + \\ &\left[2t\left[\frac{N}{4} + \frac{y(P_4 - P_5)}{2t}\right]^2 + [y(1-P_4)]\, N - \frac{tN^2}{4} - \frac{y^2(1-P)^2}{t}\right]. \end{aligned} \tag{12}$$

Equation (12) can be used to analyze the overall impact of a new arena district in this case.

Before we study the general case, let us first consider the extreme case where the new arena district drives all service providing firms at the existing consumption center out of business, i.e., $n_5 = 0$. In this case, the arena district becomes the only place that residents of the city can consume services, therefore, the number of other service providing firms at the arena district will be n_2, the same as in the case where sports facility is located at the existing consumption center. The difference is that the rent gradient in the city will be reversed, even through the city-level aggregate housing value remains the same. The change of city welfare net of the profits of the sports team in the extreme case will be the same as $TW_1 - TW_0 - \Pi'_{ps}$, which is shown to be positive in Appendix A.3.

In the extreme case, the city ends up with an arena district as the new and only consumption center. Less extreme and more realistic outcomes occur when there are still some services $n_5 > 0$ provided at the existing consumption center after the creation of an arena district. Appendix A.4 proves $TW_3 - TW_0 - \Pi_{ps}^{ad} \geqslant 0$ in an equilibrium with symmetric price level in the existing consumption center and in the arena district and symmetric services. Asymmetric equilibria are not analytically tractable.

4.3 Discussion

A comparison of the equilibrium outcomes of different locational choices for a new sports facility in a city provides new insight into the choices made by local decision makers who choose to pursue a sports-led economic development plan and explains the existing urban development patterns in cities with professional sports teams. Locating a new sports facility at $z = \frac{N}{2}$ generates a larger local welfare gain than locating the sports facility at the existing consumption center unless the competition from the new arena district drives all service providing firms at the existing consumption center out of business. This result justifies observed behavior by local decision makers in terms of location choice of professional sports facilities: cities more often choose to construct new professional sports facilities in neighborhoods with low property value and low economic activity.

Casual observation shows that a large number of bars and restaurants can be found near urban sports facilities. Agglomeration benefits explain why this occurs. Because professional sports events attract large numbers of fans, they generate a positive demand externality that can be taken advantage of by other service producing firms. The local area will have more service providing firms than would exist if there was no sports facility. In particular, an additional n_4 service producing firms will open and provide services to residents at the location of a new sports facility. This effect lies at the heart of the claims that professional sports facilities can revitalize urban neighborhoods.

Proponents of subsidies for new sports facility construction projects typically claim that all residents of a city will benefit from the construction of a new professional sports facility. A comparison of the initial long run equilibrium and the new equilibrium with an arena district shows that introducing professional sports games to a city is not a Pareto improvement. The creation of an arena district generates both losers and winners. The losers are service providers at the existing consumption center, who either experience a reduction of profits or have to exit the market, and owners of residential properties within a certain range of the existing consumption center, who experience a reduction in housing values due to the decline of services supplied in the existing consumption center. The winners are service providers in the arena district, who make positive profits because of the agglomeration effects of the new sports facility,[6] and property owners within a certain

[6] Whether these service providers will be able to keep the profits is a question we will discuss in Section

range of the new professional sports facility, who experience an increase in property value due to the increase of service supply in the area.

The overall positive externality generated by a sports facility and the within-city redistribution effect of the sports facility take place before any transfer between a city and a professional sports team. We call this "first-order gain" and the "first-order within-city redistribution effect". These do not capture the total impact of a new sports facility on the local economy, because attracting a sports team to a city almost always involves a substantial subsidy from the city to the team. For example, a subsidy reduces the total welfare gain experienced in the city if the team owner is not a resident of the city. In addition, the financing of the subsidy may also redistribute wealth within the city. In Section 5, we analyze the bargaining game that takes place between cities and monopoly leagues to investigate the determination of the size of the subsidy. In Section 6, we discuss the total within-city redistribution effect of a sports team taking into account the financing of the subsidy.

5 Monopoly Sports Leagues, Cities, and Expansion

The major professional sports leagues in North America enjoy explicit and implicit exemptions from anti-trust law. Ross (2003) reviews the issues surrounding antitrust policy and professional sports leagues. Professional sports leagues operate as monopolies that control the number and location of teams in leagues. Professional sports leagues maximize the profits of all teams by restricting the number of teams relative to the number that would exist under free entry into the market for professional sports teams. This creates a situation where a number of cities exist that could support a professional sports team and would like to have one, but cannot host a team because of the monopoly power wielded by leagues operating with antitrust exemptions. For example, Los Angeles, one of the largest metropolitan areas in North America, could clearly support a professional football team, but has not had one since 1994, when the Raiders returned to Oakland and the Rams left for St. Louis.

The provision of professional sports involves sports leagues, who maximize the profits of all teams in the league through the exercise of monopoly power. This forces cities and local governments that want to host a professional sports team to compete against each other for expansion teams, or to attract existing teams to move to a new location. Cities compete for new or existing teams by offering subsidies for the construction of

6.

new stadiums or arenas. Because this interaction affects almost all new sports facility construction projects in North America, we develop a bargaining model that describes the interaction between monopoly leagues and cities seeking professional sports teams.

Consider the strategic interaction between a monopoly professional sports league considering expansion and two cities who would like to have an expansion team. While this model describes league expansion, it can also be applied to any situation involving civic competition for a professional sports team, including an existing team threatening to move to a new location.

The game contains two stages. First, the league determines that total profits will increase if it adds an additional team. We do not explicitly model this decision, but simply assume that the league has determined that league-wide profits will be increased by expansion. Professional sports leagues in North America have periodically expanded over the past 100 years and remain profitable, so this assumption appears reasonable. In the second stage, the league announces its expansion plans and invites potential hosts to bid for the rights to host the expansion team. If no cities decide to bid for an expansion team, then the game ends; if one or more cities decide to bid for the expansion team then the suitors will bid for the expansion team, and the league will choose a city to host the team based on the bidding.[7]

We focus on the simple case of two competing cities bidding for an expansion franchise. Let b_k be the bid of city k, $k = 1, 2$. b_k can be positive or negative. $b_k > 0$ means that city k subsidizes the team, and $b_k < 0$ means that city k taxes the team. In essence, b_k is a lump sum transfer between the city and the league.

Assume that the owners of the professional sports league are not a residents of either city, but the owners of property and other service producing firms are residents of the cities. The city government acts as the social planner and chooses b_k to maximize the welfare of the residents of the city, i.e., $TW(y_k) - \Pi_{ps}(y_k) - b_k$, such that $TW(y_k) - \Pi_{ps}(y_k) - b_k \geqslant TW_0(y_k)$. The league will choose to locate the new franchise in the city that maximizes $\Pi_{ps}(y_k) + b_k$.

First consider the case of two cities with identical average income, i.e., $y_1 = y_2 = y$. The cities have the incentive to increase their bid until all the city level welfare gains are transferred to the team. In equilibrium, both cities will bid

[7] In the actual expansion process, potential ownership groups participate in the bidding. This game abstracts from the role played by ownership groups in the bidding process to focus on the role that subsidies for facility construction and operation play. In many cases, state and local governments are willing partners with ownership groups seeking expansion teams or existing teams interested in moving.

$$b = TW(y) - \Pi_{ps}(y) - TW_0(y) \geqslant 0.$$

Notice that the bids are proved to be non-negative in the previous section: when two cities with identical income compete for an expansion the team, a positive subsidy will be provided by the host city regardless of the team's profits before the subsidy, because the cities must bid against each other to get the expansion team. The league will be indifferent between the two cities and earn profits of

$$\Pi_{ps}(y) + b = TW(y) - TW_0(y)$$

following expansion. This expression describes the league's decision in the auction. If $TW(y) - TW_0(y) < 0$, the league will not expand because the fixed cost f_{ps} is bigger than the sum of team revenue and city-level externality generated by the team. If $TW(y) - TW_0(y) \geqslant 0$, the league will expand into one of the cities and will get all the gain associated with the facility construction project and the additional service provision in the city. The welfare of the host city as a whole will be the same.

From the perspective of the host city of the expansion team, the result is efficient: a sports facility construction project with a positive net social welfare will be undertaken and the one with a negative net gain will not.[8] From the perspective of the two competing cities, it is not efficient: the other city, which is exactly the same as the host city, will not have a team. This inefficiency is the result of the league's monopoly power. It supplies fewer teams to get a larger transfer from the city that is awarded the expansion franchise.

Next, consider two cities with different income levels. Assume, city 1 has a higher average income than city 2, i.e., $y_1 > y_2$. The government of city 1 knows that the maximum of bid of city 2 will be

$$b_2 = TW(y_2) - \Pi_{ps}(y_2) - TW_0(y_2)$$

and that bidding a small amount more than b_2 wins the auction. The league knows that the total gain will be larger if it locates in city 1. The game turns into a standard case of

[8] This result assumes that all agents have full information. However, information asymmetries may exist in reality. The cities may not know what the actual impact of the expansion team will be on the local economy, or may not have an accurate forecast of the cost of building a new sports facility. Coates and Humphreys (1999) show that the tangible economic impact of a new professional sports team on the local economy is negative, but most prospective "economic impact" studies commissioned by cities to estimate the future economic impact of a new sports team project large positive increased in employment and income. Long (2005) estimates that the average sports facility construction project costs 40% more than initially reported and also documents significant cost overruns in these construction projects.

Nash bargaining with an outside option. The total gain if the team locates in city 1 is

$$TW(y_1) - TW_0(y_1)$$

If $TW(y_1) - TW_0(y_1) < 0$ and expansion agreement will not take place between city 1 and the the league when two parties are rational and have full information. This means that no team will be added to the league.[9]

If $TW(y_1) - TW_0(y_1) \geqslant 0$, city 1 will make a higher bid than city 2 and be the host of the expansion team. The total gains from expansion will be divided between city 1 and the league. The share of the gains will depend on the outside options of both parties.

For city 1, the outside option is simple - no team and no change in welfare. For the league, there are two possibilities. The first possibility is that the total gain for city 2 is non-positive

$$TW(y_2) - TW_0(y_2) \leq 0.$$

In this case, city 2's income is too low to generate a positive welfare gain and the potential service agglomeration benefits from having an expansion team. The outside option for the league in this case is no expansion and no increase in league wide profits. This is a case where neither party has a positive threat point. The Nash solution to this bargaining game is an equal split of the gains: the private profits of the team plus the bid of the city will equal to a half of the total gain

$$\Pi_{ps}(y_1) + b_1 = \frac{1}{2}[TW(y_1) - TW_0(y_1)],$$

which implies that the bid of city 1 will be

$$b_1 = \frac{1}{2}[TW(y_1) - TW_0(y_1)] - \Pi_{ps}(y_1)$$

Notice that b_1 can be positive or negative, depending on the distribution of the gains from expansion before the transfer. If the total gain of city 1, $TW(y_1) - TW_0(y_1)$ is larger than the team's private profits, $\Pi_{ps}(y_1)$, then the city will subsidize the team. Otherwise, the city will tax the team.

The second possibility is the case where the total gains from expansion in city 2 are positive

[9]Recall that city 2 has a lower income than city 1. If the total welfare change generated by the team is negative in city 1, it will be negative in city 2 as well.

$$TW(y_2) - TW_0(y_2) > 0$$

In this case, the league will have an outside option – expanding into city 2 instead of city 1. Since city 2 will bid $b_2 = TW(y_2) - \Pi_{ps}(y_2) - TW_0(y_2)$, the payoff of the outside option to the team is $\Pi_{ps}(y_2) + b_2 = TW(y_2) - TW_0(y_2)$, the threat point of the league. If $TW(y_2) - TW_0(y_2) \leq \frac{1}{2}[TW(y_1) - TW_0(y_1)]$, the outside option of the league will not change the bargaining power of both party, therefore, the Nash solution still applies. If $TW(y_2) - TW_0(y_2) > \frac{1}{2}[TW(y_1) - TW_0(y_1)]$, city 1 has to offer a transfer to make the league's payoff from expanding into city 1 at least as big as its payoff from the outside option:

$$\Pi_{ps}(y_1) + b_1 = \Pi_{ps}(y_2) + b_2 = TW(y_2) - TW_0(y_2),$$

which implies that

$$b_1 = TW(y_2) - TW_0(y_2) - \Pi_{ps}(y_1).$$

Again, b_1 can be positive or negative in theory, depending on the relative size of the payoffs from the league's outside option, $TW(y_2) - TW_0(y_2)$, and its private profits in city 1, $\Pi_{ps}(y_1)$. If $b_1 = [TW(y_2) - TW_0(y_2)] - \Pi_{ps}(y_1) > 0$, then city 1 will subsidize the team. Otherwise, the winning city will tax the team. In reality, we usually observe subsidies from the city, suggesting that the payoffs from the league's outside option dominates the private profits of the team in the winning city.

The bargaining outcome for the league will be

$$\Pi_{ps}(y_1) + b_1 = \begin{cases} TW(y_2) - TW_0(y_2), & \text{if} TW(y_2) - TW_0(y_2) > \frac{1}{2}[TW(y_1) - TW_0(y_1)] \\ \frac{1}{2}[TW(y_1) - TW_0(y_1)], & \text{otherwise.} \end{cases}$$

After the transfer of b_1 to the league, the change in net welfare for city 1 will be

$$\begin{aligned} & TNW_1 = TW(y_1) - TW_0(y_1) - \Pi_{ps}(y_1) - b_1 \\ & = \begin{cases} [TW(y_1) - TW_0(y_1)] - [TW(y_2) - TW_0(y_2)], & \text{if } TW(y_2) - TW_0(y_2) > \frac{1}{2}[TW(y_1) - TW_0(y_1)] \\ \frac{1}{2}[TW(y_1) - TW_0(y_1)], & \text{otherwise.} \end{cases} \end{aligned}$$

The results of the game between the league and the two cities can be summarized in the following proposition

Proposition 1 *When a monopoly sports league considers expanding into one of two competing cities ($y_1 \geqslant y_2$), if an expansion team is added to one city, the leagues' share of payoffs from expansion decreases with the income difference between the two cities:*

- *when the income difference between the two cities is large enough such that city* 2 *is an irrelevant outside option for the league ($TW(y_2) - TW_0(y_2) \leq \frac{1}{2}[TW(y_1) - TW_0(y_1)]$), city* 1 *will offer $b_1 = \frac{1}{2}[TW(y_1) - TW_0(y_1)] - \Pi_{ps}(y_1)$, and the league and city* 1 *will both get a half of the gain from expansion, $\frac{1}{2}[TW(y_1) - TW_0(y_1)]$.*

- *when the income difference between the two cities is small such that the competing city is a relevant outside option for the league, city* 1 *will offer $b_1 = TW(y_2) - TW_0(y_2) - \Pi_{ps}(y_1)$, the league will get $TW(y_2) - TW_0(y_2) > \frac{1}{2}[TW(y_1) - TW_0(y_1)]$, and city* 1 *will get $[TW(y_1) - TW_0(y_1)] - [TW(y_2) - TW_0(y_2)]$, less than a half of the gain from expansion.*

- *when the income difference between the two cities is zero ($y_1 = y_2 = y$), city* 1 *will offer $b_1 = TW(y) - TW_0(y) - \Pi_{ps}(y)$, the league will get the entire gain from the expansion, $TW(y) - TW_0(y)$, and city* 1 *will get no welfare increase.*

The analysis suggests that, under the current antitrust exemption enjoyed by sports leagues, it is very likely that the host city of an expansion franchise will not gain much as a result of expansion, except for intangible benefits related to "world class city" status and civic pride. When professional sports leagues expand, the cities that compete to host the expansion franchise tend to be similar. The NFL last expanded in 2002, when the Houston Texans were added to the league. The expansion process began in 1998, and the three cities competing for this expansion franchise were Toronto, North America's fifth largest media market, Los Angeles, the second largest media market in North America, and Houston, the fourth largest media market in North America. The expansion franchise was awarded to Houston. The total public cost of this facility was $507 million. Based on our model, the size of this subsidy can be attributed to the large outside option for the league generated by the presence of Los Angeles and Toronto as the other potential expansion cities.

Proposition 1 has several important implications regarding the size of the city subsidy to the league. First, the size of the subsidy b_1 increases with the fixed costs f_{ps} of the team. The two most recent sports facility construction projects in New York City cost well in excess of one billion dollars. Second, the size of the subsidy b_1 decreases with the team's before-transfer profits $\Pi_{ps}(y_1)$. North American professional sports franchises are notoriously unwilling to release audited financial data, but often claim to make large losses when negotiating with cities for facility construction subsidies. This behavior maximizes the size of the subsidy, based on the predictions of this bargaining model. Third, the size of the subsidy is not limited by the cost of the proposed sports facility. The before-transfer welfare increase in the host city $TW(y_1) - TW_0(y_1)$ or in the competing city $TW(y_2) - TW_0(y_2)$ plays an important role. The total public subsidy often exceeds the cost of the new sports facility built for an expansion franchise, or for an existing franchise threatening to move. Finally, over time, income growth in cities without teams will increase the size of the subsidy from host cities to teams.

Zimbalist and Long (2006) document an increase in public subsidies for professional sports facility construction over time. The model suggests that income growth in US cities and the antitrust exemption enjoyed by leagues may contribute to the observed increase of subsidies provided to professional sports teams since the 1950s. Because of income and population growth, more and more cities are able to generate positive social gains from the presence of a sports team. Monopoly North American sports leagues exercise monopoly power by supplying fewer teams than would be present under free entry into the market. The limited supply and the increase in demand for teams induce city competition for teams, driving up subsidies. For dominant host cities that are not threatened by competition, the increase in construction costs of sports facilities, seen in Table 1 and 2 in Siegfried and Zimbalist, 2000 and Zimbalist and Long (2006) may explain the increase in subsidies to teams. Increasing income in society drives larger city-level welfare gains, and also leads to larger subsidies from host cities to teams.

6 Welfare Redistribution in the Host City

Above, we show that the introduction of a new professional sports team in a city leads to welfare redistribution within the host city before any subsidy is provided by the city to the team. This section extends the welfare redistribution analysis in Section 4 to incorporate the specific details of the subsidy provided by the city to the team. Note that this public subsidy could take the form of public financing of the structure, land, and infrastructure like roads and sewerage around the facility. Long (2005) discusses the myriad forms these public subsidies can take.

Focusing on the case that the city planner uses a sports facility construction project to revitalize declining neighborhood, we discuss three issues: 1) the change and distribution of profits in the city, 2) the financing of the subsidy, and 3) the change in housing values in the city.

6.1 The Change and Distribution of Local Profits

A new sports facility can lead to new economic development around the facility, in the form of other service providing firms co-locating in the arena district. The exact distribution of profits depends on how the government allocates business licenses to the service providing firms that co-locate with the new sports facility. Several allocation mechanisms are possible. If the government auctions away the licenses, then it will be able to extract all the agglomeration profits from the new service providers. However, this rarely occurs in practice. If the government gives out the licenses for free, then whoever gets the licenses will also get the profits. In some cases, the team owners are explicitly, or implicitly through the site selection process, given the rights to development around new publicly financed sports facilities. This case clearly provides an additional subsidy to the team owner.

Unless the new sports facility is far away from any existing consumption center that their impact zones do not overlap, the new development around the sports facility will create competition in the service providing sector and reduce profits for service providing firms at the existing consumption center. Coates and Humphreys (2003) show that employment in the hospitality and food and beverage sectors decline in cities that attract new professional sports teams, an outcome consistent with this observation. Many service providing firms like bars and restaurants are owned and operated by entrepreneurs who are local residents. They may suffer from losing profits or their business.[10]

6.2 Financing Subsidies

The positive externality generated by a new sports facility has two components: profits from service providing firms locating close to the sports facility and increases in the aggregate housing value in the city. The city will have to finance the subsidy unless the city government owns all of housing and earns revenues from auctioning business licenses for these new and profitable service provision opportunities.

Cities use many different tax schemes to finance subsidies for professional sports, including general tax revenues, user fees like ticket taxes, tax increment financing (TIF) schemes, and revenues from sources like government operated lotteries. How different

[10]The model abstracts from business ownership and local labor market effect and assumes that individual resident earns y.

taxes financing methods affect within-city welfare redistribution is an interesting and complex question that we do not fully address here. We discuss the basic economic intuition behind financing subsidies for professional sports facilities and investigate the effect of financing using a property tax.

The incidence of any tax depends on the flexibility of the different groups affected by a tax. Consider a general sales tax. If consumers' alternative to the imposition or increase of an existing sales tax to finance a new sports facility is moving to a different nearby city or suburb that does not increase sales taxes, individuals who move to avoid the tax still obtain a reservation utility y and in equilibrium property values in the city decrease, because dwellings are not mobile. The incidence of a sales tax may fall on property owners in the city. In reality, consumers are not perfectly mobile because of transaction costs and employment opportunities. Most likely consumers and property owners will share the incidence of a sales tax.

A user tax, in this case a tax on tickets to games held in the new facility, affects the team and the fans. As long as the team does not always sell out all the seats, the incidence of this user tax will be shared by the team and the fans depending on the elasticity of supply and demand for seats. In this case, the incidence of the tax will be borne by people who benefit directly from the subsidy, which has desirable equity implications.

One common method of financing subsidies for sports facilities is through property taxes. In many cases, this takes the form of a Tax Increment Financing (TIF) program under which the increase in property values in an arena district generates additional, or incremental, property taxes and these additional tax revenues are used to finance the subsidy. The American Airlines Center in Dallas, home of the Dallas Mavericks of the NBA and Dallas Stgars of the NHL, the KFC Yum! Center in Louisville Kentucky, and a number of new sports facilities in the planning stages in Los Angeles, Edmonton, Alberta, and Newport News, Virginia are, or will be financed using property taxes generated in a TIF district.[11]

Assume the government finances the subsidy for a new professional sports facility through a property tax, and the property tax is a simple flat rate τ on housing values. Note that in a simple one-period model, the before-tax housing value and rent are equivalent. The total revenue raised by a flat property tax will be

$$R_1 = 2\tau \int_0^{N/2} p^h(z)dz$$

[11] Weber (2013) provides a recent survey of TIF districts.

Assuming a balanced government budget $R_1 = b_1$ gives us the tax rate required to raise sufficient property tax revenues to finance the subsidy

$$\tau^b = \frac{b_1}{2\int_0^{N/2} p^h(z)dz}. \tag{13}$$

From Equation (13) the budget balancing property tax rate, τ^b increases with the size of the subsidy required to attract a team to the city, b_1. The after tax property value, denoted by $p^{h,\tau}(z, y)$, will be $(1 - \tau^b)p^h(z, y)$.

The change in after-tax property value and welfare generated by a new sports facility is summarized in the following proposition:

Proposition 2 *If the government finances the subsidy using a proportional property tax, there will be a residence* $\widehat{z} \in (\widetilde{z}, \frac{y(1-P)}{t})$ *such that* $p^{h,\tau}(\widehat{z}, y) = y(1 - P) - t\widehat{z}$.

1. *After-tax housing value will decrease for houses located in* $z \in [0, \widehat{z})$ *and will increase for houses located in* $z \in (\widehat{z}, \frac{N}{2}]$.

2. *The change in housing values increases with* z *for* $z \in \left[0, \frac{N}{2}\right]$. *The magnitude of the negative change in housing value in* $z \in [0, \widehat{z})$ *decreases with* z *and the magnitude of the positive change in housing value in* $(\widehat{z}, \frac{N}{2}]$ *increases with* z.

Proof. *See Appendix A.5.* ■

The construction of a new sports facility for a professional sports team has a differential impact on housing values in the city, and the impact depends on proximity to the facility. In the case of property tax financing, the winners are those property owners who live close enough to the new facility to experience an increase in property values large enough to offset the higher property taxes collected to subsidize the facility. Empirical evidence shows that professional sports facilities increase rents and property values within certain distance of a new sports facility. Tu (2005) and Feng and Humphreys (2012) find a positive relationship between professional sports facilities and nearby residential property values, but no effect on residential property values farther from facilities. Carlino and Coulson (2004) and Coates and Matheson (2011) find a positive relationship between professional sports and rents in larger metropolitan areas. Dehring et al. (2007) find a positive relationship between residential property values near a new professional football stadium in Dallas. The prediction that the construction of a new publicly funded facility for a team leads to a loss of after-tax property value far from the facility is consistent with evidence in Dehring et al. (2007) and Kiel et al. (2010).

The welfare redistribution associated with a new sports facility is also consistent with the observed voting patterns in referendums on subsidies for sports facility construction and renovation projects. Coates and Humphreys (2006) found that individuals living closer to Lambeau Field in Green Bay, Wisconsin were more likely to vote in favor of a sizable tax increase to finance the renovation of this stadium. Dehring et al. (2008) found that homeowners in Dallas Texas were more likely to vote for a referendum providing \$325 million in direct support, and a package of local tax rate increases, to pay for the construction of a new football stadium for the Dallas Cowboys. They also report evidence that residential property prices were affected by announced locations for the new facility.

7 Conclusions

We develop a model of economic activity in an urban area that includes consumption and production of a traded good and a number of non-traded services, consumer travel to a consumption center, and housing values. We introduce a new sports facility into this area and show that this new sports facility generates agglomeration effects in the local economy. We also model the bargaining between a city and a professional sports league to investigate the determination of the subsidy needed to attract a new team to a city. The model shows that such a subsidy can be justified by the agglomeration effects generated by a new sports facility in that total local welfare increases when a new sports facility and team are introduced in the local economy. However, introducing a new team and subsidizing the construction of a new facility is not a Pareto improvement unless the team and the agglomerating services do not compete with the existing service producing firms. If such competition happens, all service producing firms at the original consumption center in the city will earn lower profits and some will exit due to economic losses.

The size of the agglomeration effects depends on the number of customers who attend games at the facility and consumer services in and around the new facility. This will be affected by the nature of the league schedule and size of the facility. Average attendance at a National Basketball League (NBA) game was about 13,000, average attendance at a Major League Baseball (MLB) game was about 23,000, and average attendance at a National Football League (NFL) game was about 57,000 over the period 1969-2001. In 2005 total attendance was more than 74 million at MLB games, more than 21 million at

NHL games, and more than 17 million at NFL games.[12] Despite the high average game attendance, the NFL season is only 16 games long, only half the games are played at home, and most games are played on Sunday afternoon. The MLB season is 162 games long and games are played almost every day during the regular season. The NBA season is 82 games long, many NBA teams share arenas with NHL teams, and many of these arenas also host concerts and other events year round. The number of consumers attending MLB games dwarfs the other main professional sports in North America, and arenas are used more intensely than other facilities. The size of the agglomeration benefits generated from a professional sports facility will be proportional to the number of consumers attracted, which means that MLB stadiums and arenas used by NBA and NHL arenas are likely to generate more co-located service providers and more agglomeration benefits than NFL stadiums. The agglomeration benefit justification for subsidies for sports facility construction projects does not apply uniformly to all professional sports facilities.

The model highlights the importance of the antitrust exemption enjoyed by professional sports leagues in North America. Because leagues control the number and location of franchises, many cities that could profitably host a professional sports team cannot have one, and a number of potential new homes exist for any team owner who wants to extract a bigger subsidy from the local government. The restricted supply of franchises forces cities to compete with one another to attract a new team or an existing team to relocate. The bargaining game analyzed in Section 5 shows how the presence of competing cities allows the league to extract the largest possible subsidy from local governments. Even in the presence of agglomeration benefits, the monopoly power of leagues prevents residents of cities from experiencing the full benefits generated by sports facilities because the increased welfare generated by the increased variety is almost completely extracted by the league. The justification for the explicit antitrust exemption granted to Major League Baseball rests on the fallacy that professional sports do not constitute interstate commerce and has not been challenged for nearly 100 years (Mozes and Glicksman (2011). The results here suggest that the restrictions on entry generated by monopoly power granted to leagues may be reducing consumer welfare by making it difficult for cities to overcome the coordination problems that reduce the supply of services in some areas. If more professional sports teams existed, more agglomeration effects would be generated. Also, more professional sports teams in more cities would reduce the ability for leagues to extract subsidies from cities in competition for new or existing franchises.

[12] Total attendance at NHL games was almost 20 million in 2004, but the 204-2005 season was canceled due to a labor dispute.

A large body of literature focused on estimating the economic impact of professional sports on the urban economy emerged over the last 30 years. While this literature examined many of the economic aspects of professional sports, including the effect on income, employment, tax revenues, rents, property values, crime, and other factors, to date, this literature has had relatively little theoretical grounding. The model developed here provides a theoretical basis for this literature, and, as we discuss above, can help to place much of this literature in context.

While the model explains the impact of the agglomeration benefits generated by professional sports facilities and the effect of sport-led urban redevelopment on property values and local welfare, it abstracts from local labor markets and migration between cities. Extending the model to incorporate these two factors will help us consolidate the existing empirical results on professional sports and local labor markets (Coates and Humphreys (1999, 2003); Carlino and Coulson (2004)) and inspire empirical investigation into professional sports and city population growth.

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A Appendices - For Online Publication

A.1 Derivation of the indirect utility of residents who live in the impact zone of the consumption center

First, the relative demand for traded goods can be written

$$x = s_j a_j^{-\sigma} (p_j)^{\sigma}$$

Next, rewrite the relative demand for service i in Equation (4) as

$$s_i = s_j \left(\frac{a_i}{a_j}\right)^{\sigma} \left(\frac{p_i}{p_j}\right)^{-\sigma}$$

Multiply both sides by p_i and aggregate over the number of services n

$$\sum_{i=1}^{n} p_i s_i = \left(\frac{p_j}{a_j}\right)^{\sigma} s_j \sum_{i=1}^{n_1} a_i^{\sigma} (p_i)^{1-\sigma}$$

$x + \sum_{i=1}^{n} p_i s_i$ is the consumer's total expenditure on good x and services, which is consumer's income minus the rent, $y - p_0^h$

$$y - p_0^h = s_j a_j^{-\sigma} (p_j)^{\sigma} + \left(\frac{p_j}{a_j}\right)^{\sigma} s_j \sum_{i=1}^{n_1} a_i^{\sigma} (p_i)^{1-\sigma}$$

The consumption for service j is therefore

$$\begin{aligned} s_j &= \frac{y - p_0^h}{a_j^{-\sigma}(p_j)^{\sigma} + \left(\frac{p_j}{a_j}\right)^{\sigma} \sum_{i=1}^{n_1} a_i^{\sigma} (p_i)^{1-\sigma}} \\ &= \frac{a_j^{\sigma}(y - p_0^h)}{(p_j)^{\sigma}[1 + \sum_{i=1}^{n_1} a_i^{\sigma} (p_i)^{1-\sigma}]} \end{aligned}$$

Plug the optimal consumption bundle into the utility function to obtain an expression for indirect utility

$$
\begin{aligned}
U_0 &= \left[[s_j a_j^{-\sigma} \left(\frac{1}{p_j}\right)^{-\sigma}]^{\frac{\sigma-1}{\sigma}} + \sum_{j=1}^{n_1} a_j \left(s_j\right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \\
&= \left[\left(\frac{(y-p_0^h)^{\frac{\sigma-1}{\sigma}}}{[1+\sum_{i=1}^{n_1} a_i^{\sigma} \left(p_i\right)^{1-\sigma}]^{\frac{\sigma-1}{\sigma}}} \right) + \sum_{j=1}^{n_1} \left(\frac{(p_j)^{1-\sigma} a_j^{\sigma} (y-p_0^h)^{\frac{\sigma-1}{\sigma}}}{[1+\sum_{i=1}^{n_1} a_i^{\sigma} \left(p_i\right)^{1-\sigma}]^{\frac{\sigma-1}{\sigma}}} \right) \right]^{\frac{\sigma}{\sigma-1}} \\
&= \frac{(y-p_0^h)}{[1+\sum_{i=1}^{n_1} a_i^{\sigma} \left(p_i\right)^{1-\sigma}]^{\frac{1}{1-\sigma}}}
\end{aligned}
$$

A.2 The relationship between city welfare and the local price index

When $\frac{p_0^h}{t} < \frac{N}{2}$, i.e., $P > 1 - \frac{Nt}{2y}$, $TW = Ny + \sum_{j=1}^{n} \left[\frac{2Ny^2(1-P)P^{\sigma} a_j^{\sigma}}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P)^2}{t}$. Differentiate TW with respect to P, we get

$$
\begin{aligned}
\frac{\partial TW}{\partial P} &= \sum_{j=1}^{n} \frac{\partial \Pi_j}{\partial P} + \frac{\partial \frac{y^2(1-P)^2}{t}}{\partial P} \\
&= \sum_{j=1}^{n} \{ \frac{2a_j^{\sigma} y^2 P^{\sigma-1}}{\sigma t p^{\sigma-1}} [\sigma - (\sigma+1)P] \} - \frac{2y^2(1-P)}{t} \\
&= \frac{2y^2 P^{\sigma-1}}{\sigma t} [\sigma - (\sigma+1)P] \sum_{j=1}^{n} a_j^{\sigma} p^{1-\sigma} - \frac{2y^2(1-P)}{t} \\
&= \frac{2y^2 P^{\sigma-1}}{\sigma t} [\sigma - (\sigma+1)P](P^{1-\sigma} - 1) - \frac{2y^2(1-P)}{t} \\
&= -\frac{2y^2}{\sigma t} \{ [\sigma - (\sigma+1)P] P^{\sigma-1} + P \} \\
&< 0
\end{aligned}
$$

When $\frac{p_0^h}{t} \geqslant \frac{N}{2}$, i.e., $P \leq 1 - \frac{Nt}{2y}$, $\Pi_j = \frac{Nya_j^{\sigma} P^{\sigma}}{\sigma p^{\sigma-1}} - f_j$, and $2\int_0^{N/2} p(z)dz = Ny(1-P) - \frac{tN^2}{4}$, therefore, $TW = Ny + \sum_{j=1}^{n} \left[\frac{Nya_j^{\sigma} P^{\sigma}}{\sigma p^{\sigma-1}} - f_j\right] + Ny(1-P) - \frac{tN^2}{4}$. Differentiate TW with respect to P, we get

$$\begin{aligned}
\frac{\partial TW}{\partial P} &= \sum_{j=1}^{n}\frac{\partial \Pi_j}{\partial P} + \frac{\partial Ny(1-P)}{\partial P} \\
&= \sum_{j=1}^{n}\frac{Na_j^{\sigma}yP^{\sigma-1}}{p^{\sigma-1}} - Ny \\
&= NyP^{\sigma-1}\left[\sum_{j=1}^{n}a_j^{\sigma}p^{1-\sigma}\right] - Ny \\
&= NyP^{\sigma-1}(P^{1-\sigma}-1) - Ny \\
&= -NyP^{\sigma-1} \\
&< 0
\end{aligned}$$

A.3 The impact of a new sports facility at the initial consumption center on the total welfare in the city (net of the team's own profits)

Note that service $j \in [n_2+1, n_1]$ would incur loss when the price index is P', therefore,

$$\begin{aligned}
TW_1 - \Pi'_{ps} &= Ny + \sum_{j=1}^{n_2}\left[\frac{2Ny^2(1-P')P'^{\sigma}a_j^{\sigma}}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P')^2}{t} \\
&> Ny + \sum_{j=1}^{n_1}\left[\frac{2Ny^2(1-P')P'^{\sigma}a_j^{\sigma}}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P')^2}{t}.
\end{aligned}$$

Given $\sum_{j=1}^{n} f_j$, the city welfare TW and the price index P have a negative relationship as proved in Appendix A.2. Because $P' \leq P$,

$$\begin{aligned}
TW_1 - \Pi'_{ps} &> Ny + \sum_{j=1}^{n_1}\left[\frac{2Ny^2(1-P')P'^{\sigma}a_j^{\sigma}}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P')^2}{t} \\
&\geqslant Ny + \sum_{j=1}^{n_1}\left[\frac{2Ny^2(1-P)P^{\sigma}a_j^{\sigma}}{\sigma t p^{\sigma-1}} - f_j\right] + \frac{y^2(1-P)^2}{t} \\
&= TW_0.
\end{aligned}$$

Therefore, $TW_1 - \Pi'_{ps} - TW_0 > 0$.

A.4 City welfare when the arena district competes with the existing consumption center

In what follows, I focus on the equilibrium with symmetric price level in the existing consumption center and in the arena district ($P_4 = P_5$) and symmetric services except professional sports games. Asymmetric equilibria are not analytically tractable.

With symmetric services, service firms make zero profits in the long-run equilibrium with free entry. The emergence of the arena district shrink the impact zone of the existing consumption center and some firms have to exit. The number of services at the existing consumption center decreases from n_1 to n_5. The price level for people who consume services at the existing consumption center increase from P to P_5.

The change in city welfare

$$
\begin{aligned}
&TW_3 - TW_0 - \Pi_{ps}^{ad} \\
&= \left[\sum_{j=1}^{n_5} \Pi_j^{cc} + \sum_{j=1}^{n_4} \Pi_j^{ad} - \sum_{j=1}^{n_1} \Pi_j\right] + \left[2t\left[\frac{N}{4} + \frac{y(P_4 - P_5)}{2t}\right]^2 + [y(1-P_4)]\,N - \frac{tN^2}{4} - \frac{y^2(1-P)^2}{t}\right] \\
&= t\left[\frac{N}{8^{1/2}} + \frac{y(1-P)}{t}\right]\left[\frac{N}{8^{1/2}} - \frac{y(1-P)}{t}\right] + N[y(1-P_4) - \frac{tN}{4}]
\end{aligned}
$$

The term $N[y(1-P_4) - \frac{tN}{4}]$ is non-negative because $y(1-P_4) - \frac{tN}{4}$ is the value of the residential property at $z = \frac{N}{4}$. A sufficient condition for $TW_3 - TW_0 - \Pi_{ps}^{ad} \geqslant 0$ is $\frac{y(1-P)}{t} \leq \frac{N}{8^{1/2}}$, i.e., the initial impact zone of the existing consumption center does not cover more than $1/2^{1/2}$ (or 0.7) of the city.

A.5 After-tax property value when the subsidy to the team is financed by a proportional property tax

In long run equilibrium with free entry, the property value is

$$
p^h(z,y,n) = p_0^h - tz = \begin{cases} y(1-P) - tz, & \text{for } z \in [0, \frac{y(1-P)}{t}] \\ 0, & \text{for } z \in (\frac{y(1-P)}{t}, \frac{N}{2}] \end{cases}
$$

After the introduction of service producing firms at $z = \frac{N}{2}$ due to the construction of a new sports facility, net of the proportional property tax, the after-tax property value is

$$
(1-\tau^b)p^h(z,y) = \begin{cases} (1-\tau^b)\left[y(1-P_5) - tz\right], & \text{for } z \in [0, \widetilde{z}] \\ (1-\tau^b)\left[y(1-P_4) - t(\frac{N}{2} - z)\right], & \text{for } z \in [\widetilde{z}, \frac{N}{2}] \end{cases}
$$

where $\widetilde{z} = \frac{N}{4} + \frac{y(P_4 - P_5)}{2t} < \frac{y(1-P)}{t}$. For $z \in [\frac{y(1-P)}{t}, \frac{N}{2}]$, the change in housing value

$$(1-\tau^b)\left[y(1-P_4) - t(\frac{N}{2} - z)\right] > 0.$$

For $z \in [0, \widetilde{z}]$, the change in housing value

$$(1-\tau^b)\left[y(1-P_5) - tz\right] - \left[y(1-P) - tz\right] < 0$$

because $P_5 > P$ and $\tau^b > 0$.

For $z \in (\widetilde{z}, \frac{y(1-P)}{t})$, the change in housing value

$$\begin{aligned}&(1-\tau^b)\left[y(1-P_4) - t(\frac{N}{2} - z)\right] - \left[y(1-P) - tz\right]\\ &= (1-\tau^b)\left[y(1-P_4) - t\frac{N}{2}\right] - y(1-P) + (2-\tau^b)tz\end{aligned}$$

is an increasing function of z from

$$(1-\tau^b)\left[y(1-P_5) - t\widetilde{z}\right] - \left[y(1-P) - t\widetilde{z}\right] < 0$$

to

$$(1-\tau^b)\left[y(1-P_4) - t(\frac{N}{2} - \frac{y(1-P)}{t})\right] > 0.$$

Therefore, there must exist a $\widehat{z} \in (\widetilde{z}, \frac{y(1-P)}{t})$ such that $(1-\tau^b)\left[y(1-P_4) - t(\frac{N}{2} - z)\right] - \left[y(1-P) - tz\right] = 0$.

The change in housing values increases with z for $z \in \left[0, \frac{N}{2}\right]$. For all $z \in [0, \widehat{z})$, the change in housing values is negative, and for all $z \in [\widehat{z}, \frac{N}{2}]$, the change in housing values is positive.

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