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A rationale from the perspective of two-sided markets

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To pay or not to pay for parking at shopping malls - A rationale from the perspective of two-sided markets

By Inga Molenda* and Gernot Sieg*

A shopping mall is a meeting platform for retailers and their customers, and may therefore subsidize one particular market side. We consider suburban malls as competitive bottlenecks, because shops are mainly opened up by retail chains which operate in many malls, but whose customers visit only one suburban mall, so as to save transport costs. If the consumer-to-shop externality is larger than the shop-to-consumer externality, parking is subsidized. If customers generate high revenue, the mall operator will generally refrain from charging an entry fee, and offer free parking to its visitors. This result is shown in a model with variety-loving consumers and two competing malls at the end point of a Hotelling line on which their potential visitors, and thus the retailers' customers, are located.
JEL: L91;R41

I. Introduction

The CentrO, a large suburban shopping mall in Oberhausen (Germany), promotes its free parking by claiming that "Our parking guidance system will guide you to one of the 14,000 free parking spots" and furthermore: "you will save up to 5 € in parking fees in comparison to other shopping destinations" (CentrO, 2016). The CentrO's provision of free parking is an example of a policy that almost all suburban shopping malls adopt. In contrast, urban shopping malls such as MyZeil in Frankfurt's city center or Limbecker Platz in Essen's usually charge their visitors a positive parking fee on their premises. We follow Hasker and Inci (2014) by calling a shopping mall suburban, if the only reason to use its parking premises is the intention to shop at the mall. In contrast, an urban shopping mall provides parking spaces that might also be used by people who not (only) shop in the mall, but (also) do other things in the city center itself, who are tourists or even live in the city.

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Hasker and Inci (2014) explain the different parking pricing policies of suburban and urban shopping malls by means of consumer search.[1] In their model, a profit-maximizing suburban mall offering one good, does not charge its potential risk-averse customers for parking, because it would mean punishing at least some of them, specifically those who do not find their desired good, hence deterring some customers from visiting the mall altogether. An urban mall, however, does not provide free parking "if individuals are able to free ride on the mall's parking spaces" (Hasker and Inci, 2014, p. 1297). Ersoy et al. (2016) argue that a suburban shopping mall sets the parking fee below the marginal cost of parking, so as to internalize the crowding externalities of public transportation. More precisely, the shopping mall raises the price of the good it sells to ensure that an efficient number of its visitors use public transportation. Because the increased selling price negatively affects visitors who arrive by car without causing any externalities, the shopping mall reduces the parking fee below the marginal cost of parking to compensate them.

Flores and Kalashnikov (2017) consider reduced-price parking to be a form of third-degree price discrimination between drivers and pedestrians. If the optimal price under third-degree price discrimination prescribes offering drivers a lower price than is offered to pedestrians, a monopolistic firm can then increase profits by giving drivers a price discount in the form of complimentary parking. According to Flores and Kalashnikov (2017), it is therefore "reasonable to find in shopping centers that some shops or restaurants provide complimentary or reduced price parking while others do not." Parking is thus not free in general, but the fee can be reduced by shopping at a store or visiting a restaurant that price discriminates between pedestrians and drivers. Such pricing strategies are observable in some urban malls, but are uncommon in suburban malls.

We offer a complementary explanation for the parking pricing strategy of a mall by using the theory of two-sided markets. This theory deals with the price-setting behavior of platforms (malls), which can be interpreted as intermediaries between two groups of agents (shops and customers) whose market participation involves cross-group externalities.[2]

Such externalities exist if "the benefit enjoyed by a member of one group depends upon how well the platform does in attracting custom from the other group" (Armstrong, 2006, p. 668). With regard to shopping malls as a platform, cross-group externalities are at work when a consumer experiences a higher utility the more shops the mall accommodates, and a shop's revenue or even profit is the higher, the more consumers visit the mall. The reason for this could be that consumers love variety (Spence, 1976; Dixit and Stiglitz, 1977) so that an additional shop increases the utility of all consumers visiting the mall, because the variety of goods increases. This attracts additional visitors who, due to their love for variety, purchase from all shops. This increases the revenue or (variable profits) of all shops, which makes the mall an attractive platform for additional retailers.

[1] See Inci (2015) for a current review of the economics of parking, and Bacon (1993), Lindsey and West (1997, 1998), Lan and Kanafani (1993), Rietveld et al. (2002), Rietveld and Koetse (2008), Mingardo and van Meerkerk (2012), Dilek and Top (2013), Molenda and Sieg (2013), Hasker and Inci (2014), Ersoy et al. (2016), De Borger and Russo (2017) and Flores and Kalashnikov (2017) for studies that analyze parking in the context of retailing.

[2] In retailing, there are also inter-store externalities. For example, department stores and shops of popular clothing-retail companies like H&M, may generate positive externalities to other shops by drawing visitor traffic not only to themselves, but also to the other shops (Brueckner, 1993; Gould et al., 2005; Wheaton, 2000). Some speciality shops only benefit from traffic generated by other shops, and either generate positive externalities for shops of the same kind or not at all.

Another reason for a cross-group externality could be that consumers search for a specific product - for example shoes - which they seldom find at the first shop they visit. Thus, to reduce search costs, consumers prefer a shopping mall that offers the largest number of shoe shops. Each additional shoe shop increases the expected utility of all consumers, which attracts additional consumers searching for shoes, so that the mall is an attractive location for shoe shops.

Cross-group externalities can be internalized by the agent that acts as intermediary between the two groups by setting a price on each market side, which ensures that both sides "get on board" (Rochet and Tirole, 2006, p. 645). The operators of shopping malls "seek retailers and customers" (Rysman, 2009, p. 125) by setting a price for retailers as their shop tenants, in terms of a certain rent and a price for the consumers as their visitors, in terms of an entrance or parking fee.[3] Figure I depicts the relationships between all agents.

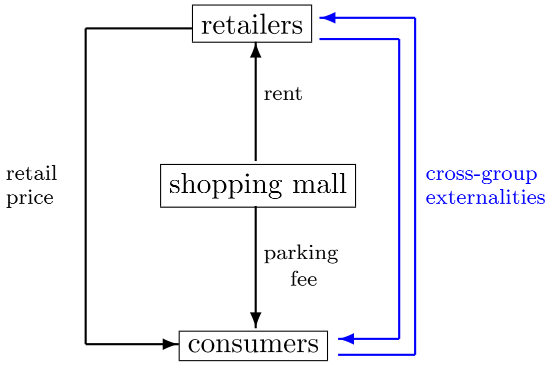

FIGURE 1. SHOPPING MALL OPERATOR AS INTERMEDIARY IN A TWO-SIDED MARKET

In the case of positive externalities that work on both market sides, as is the case at a shopping mall, a profit-maximizing intermediary targets that market side more aggressively, whose market participation involves a relatively large benefit to the other market side. Armstrong (2006, p. 682) deduces, with regard to a shopping mall's pricing decision, that it "might not wish to charge consumers for entry even if it were feasible to do so" and Rochet and Tirole (2003) use the example that some shopping malls subsidize the consumer side by offering free parking or cheap gas, and use the retailers as subsidizers. By doing so, the mall attracts more customers. This enables the mall to charge higher rents from shop owners who are willing to pay for access to customers. On the whole, subsidizing parking is part of a profit-maximizing strategy.

The determinants of equilibrium prices are the magnitude of cross-group externalities, whether fees are levied on a lump-sum or per-transaction basis, and whether agents join only one or several platforms (Armstrong, 2006). In the context of two-sided markets, an agent pursues so-called single-homing, if the agent joins only one platform. A single-homing retailer opens a shop at one of several malls. A single-homing consumer visits only one mall when making a shopping trip. By contrast, a multi-homing retailer opens shops at several malls, and a consumer multi-homes when visiting more than one mall.

[3] Of course, cross-group externalities also exist between visitors of a downtown shopping street and the retailers operating there. A shopping street, however, is not operated by a single agent. Thus, the externalities are unlikely to be internalized.

As pointed out by Hasker and Inci (2014), free parking is a possible equilibrium of a two-sided shopping mall market, but there would be a continuum of equilibria, including metered parking. In this paper, we discuss which of the equilibria are realistic. By specifying the location of two malls and of the consumers, the cross-group externalities, as well as the homing strategies of consumers and retailers, we can identify sufficient conditions for subsidized and free parking in a suburban mall.

In our model, two shopping malls located in two different suburbs of a large city compete for consumers who live between the two locations. Retail chains choose a mall as the location for a store, regardless of whether the other mall is chosen, and thereby multi-home. Consumers reduce transport costs by visiting only one mall and thereby single-home. We show that parking fees are non-positive if retailer utility (or variable profit) per customer is sufficiently large.

II. Suburban shopping malls

A. The suburban mall as a competitive bottleneck

If the shopping mall is a monopoly, its operator charges prices to both market sides that obey the Lerner index rule, but adjusts the prices by the externalities between the two market sides. The shopping mall operator is likely to subsidize parking on the mall premises through charging a parking fee that is lower than the marginal cost of providing a parking space to a visitor, if the benefit generated on the retailer side is large and/or the consumer elasticity of demand for visiting the mall is high. Thus, free parking is a possibility when the shopping mall is a monopoly.[4] However, malls usually compete with other malls or shopping streets. This competition implies that the homing strategies of retailers and consumers are important for the mall operator's pricing strategy; i.e. the homing strategies have an effect on the operator's parking fee decision. To consider competition, we analyze a mall duopoly.

In our sample of the largest 100 shopping malls in Germany, the proportion of stores that are operated by retail store chains is between 56 and 100 percent. The average proportion is 94 percent and the median is 96 percent. In all their shops, retail chains offer a similar variety of products, so that consumers usually do not have to visit two different stores of the same retail chain. Therefore, multi-homing on the retailer side and single-homing of the consumer side are appropriate assumptions. Armstrong (2006) calls a bottleneck competitive if one market side single-homes, and the other side multi-homes. If a retailer wants to sell a product to a consumer, the retailer has to open a shop in the mall, that this particular consumer visits. Therefore, the mall operators compete for the consumers, but have monopoly power over providing access to them (see Figure 2).

B. The model

Retailers which are considered as retail chains, do not make an "either-or"-decision. They run a shop in each mall, so that the two shopping mall operators do not compete with each other for the retailers. Assume that a retailer's utility

[4] For a formal analysis of the monopoly case with lump-sum fees, see for instance Armstrong (2006), and for one with per-transaction fees, see for instance Rochet and Tirole (2003).

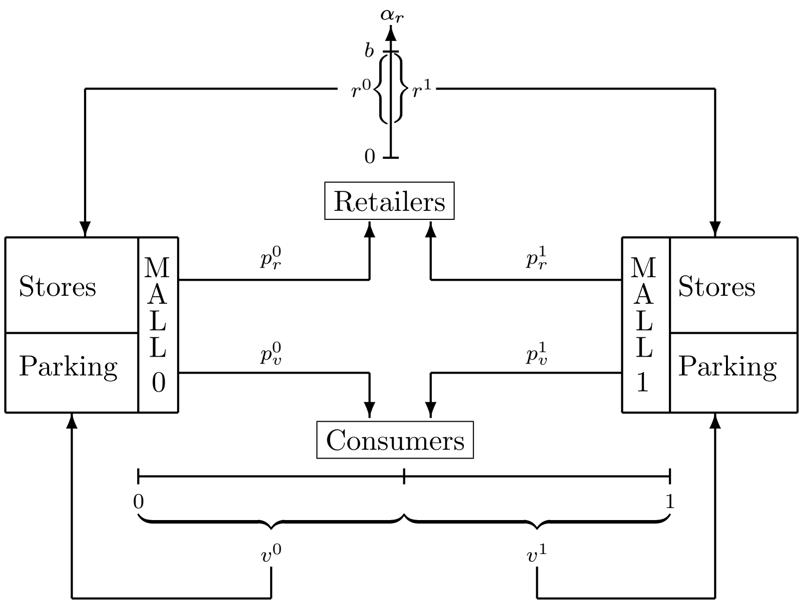

FIGURE 2. PLAYERS AND STRATEGIES

from locating in mall i is $u_r^i = \alpha_r v^i - p_r^i$, where v^i describes the number of customers visiting mall i, p_r^i the rent a shop owner at mall i has to pay, and with $\alpha_r > 0$. This utility function can also be interpreted as a profit function, assuming for instance, that the retailers offer differentiated goods and that consumers love variety and buy one unit of each good offered. The term $\alpha_r v^i$ then describes the variable profit and the store rent p_r^i, the fixed cost in a certain time period. Assume further that a retailer will locate in the mall as long as $\alpha_r v^i \geq p_r^i$ holds.

The mall operators do not have exact information on α_r, but start from the premise that α_r is uniformly distributed in a $[0, b]$-interval. If α_r is independently and identically drawn from the distribution function $F(\alpha_r)$, the mall operators will charge the same shop rent to each retailer, because the retailers are *ex ante* identical from the mall operator perspective. To obtain a positive demand for the shop area, $\alpha_r \geq p_r^i / v^i$ has to hold. The probability of this is $1 - F(\alpha_r)$, so that we calculate the number of retailers in shopping mall $i \in \{0, 1\}$

$$r^i = \phi^i(v^i, p_r^i) = 1 - F(p_r^i/v^i) = 1 - \frac{p_r^i}{b \cdot v^i} \tag{1}$$

as a function of the number of its visitors v^i and the shop rent p_r^i that the shopping mall operator charges. The function ϕ^i is increasing in v^i and decreasing in p_r^i. Thus, the larger the number of consumers who decide to visit mall i, the more retailers it accommodates ($\partial r^i / \partial v^i > 0$) and the higher the shop rent that the operator of mall i charges, the lower the number of retailers mall i accommodates ($\partial r^i / \partial p_r^i < 0$). To be able to calculate the shop rent p_r^i that ensures a specific number of retailers r^i for a given number of consumers v^i, we rearrange equation 1 to

$$p_r^i(r^i, v^i) = v^i \cdot b \cdot (1 - r^i).$$

The mall's revenue earned on the retailing side is then $R^i(v^i, r^i) = v^i \cdot b \cdot (1 - r^i) \cdot r^i$.

We assume that the consumers whose number we normalize to 1, live uniformly distributed on the $[0,1]$-interval. The number of consumers who visit mall i,

$$v^i = \Phi^i(u_v^i, u_v^j), \tag{2}$$

is a function of consumer utility from visiting mall i, u_v^i, and of consumer utility from visiting the other mall $j \neq i$, u_v^j. A consumer living at x on the $[0,1]$-interval derives a utility $u_v^i = U^i(r^i) - t \cdot |i - x| - p_v^i$ from visiting mall i, where $U^i(r^i)$ describes the utility that a consumer derives from the presence of r^i retailers in the mall, t the transport cost per unit distance from the consumer's residence at x to the mall located at i, and p_v^i the parking fee that the operator of mall i charges.

The consumers love variety, which implies that $\partial u_v^i / \partial r^i = dU^i/dr^i > 0$ holds, and we additionally assume that the marginal utility derived from an additional shop is constant: $U(r^i) = \alpha_v \cdot r^i$ with $\alpha_v > 0$.[5] The utility function conveys that we assume consumers have homogeneous preferences for shop variety. The consumers do not differentiate between shops, so that all consumers derive the same benefit from each shop operating in mall i, which we refer to as shop-to-consumer externality.

The parking fee can either be interpreted as a lump sum or as the overall price that each of the homogeneous consumers pays for parking while staying in mall i for a certain period. The consumer living at $\tilde{x}$ is indifferent between visiting mall i at location 0 or mall j at location 1 if

$$\tilde{x} = \frac{1}{2} + \frac{U(r^i) - p_v^i - (U(r^j) - p_v^j)}{2t}$$

and therefore, the number of visitors of mall i equals $v_i = \tilde{x}$ and of mall j equals $v_j = 1 - \tilde{x}$.

As in Amstrong's (2006) general model of competitive bottlenecks, the function Φ^i determining the number of mall i's visitors is increasing in u_v^i and decreasing in u_v^j. Thus, an increase in a consumer's utility from visiting mall i (through an increase in the number of retailers in mall i or a decrease in the parking fee charged by mall operator i) increases mall i's visitors ($\partial v^i / \partial u_v^i > 0$). On the other hand, if the consumers derive increased utility from visiting the other mall $j \neq i$, the number of mall i's visitors decreases ($\partial v^i / \partial u_v^j < 0$).

The profit that the operator of mall i generates, is

$$\Pi^i = v^i \cdot p_v^i + R^i(v^i, r^i) - C^i(v^i, r^i), \tag{3}$$

where $v^i \cdot p_v^i$ describes the parking revenue, $R^i(v^i, r^i) \equiv p_r^i \cdot \phi^i(v^i, p_r^i)$ the revenue from renting shop area to the retailers and $C^i(v^i, r^i)$ the total cost of serving both market sides; thus the costs of providing the parking capacities and the shop areas. We assume that $C^i(v^i, r^i) = c_v^i \cdot v^i + c_r^i \cdot r^i$, i.e. constant marginal costs for the mall to offer shop area to retailers and parking spaces to visitors. To ensure a positive number of shops at the equilibrium, we assume $c_r \leq \alpha_v/2$; i.e. the opportunity costs of retail space is small, compared to the marginal utility a store generates for consumers.

The equilibrium number of shops at mall i can be calculated as a function of

[5] For the implications of a decreasing positive marginal utility, see Footnote 7.

its visitors. In equilibrium, mall operator i produces a certain utility level $\hat{u}_v^i$ and attracts $\hat{v}^i$ visitors. The operator maximizes the mall's profit, ensuring a utility level $\hat{u}_v^i$ of consumer $\hat{v}^i$. Thus, $\hat{u}_v^i = U^i(r^i) - t \cdot |i - \hat{v}^i| - p_v^i = \text{const.}$ must hold when varying the number of shops r^i and the parking fee p_v^i, so as to maximize the mall's profit. Rearranging this equation with respect to p_v^i yields $p_v^i = U^i(r^i) - t \cdot |i - \hat{v}^i| - \hat{u}_v^i$, so we can modify equation 3 to

$$\Pi^i = \hat{v}^i \cdot \left(U^i(r^i) - t \cdot |i - \hat{v}^i| - \hat{u}_v^i\right) + R^i(\hat{v}^i, r^i) - C^i(\hat{v}^i, r^i). \tag{4}$$

Hence, for a given number of visitors $\hat{v}^i$, the operator of shopping mall i chooses to serve a number of retailers that maximizes

$$\hat{v}^i \cdot U^i(\cdot) + R^i(\hat{v}^i, \cdot) - C^i(\hat{v}^i, \cdot). \tag{5}$$

The mall operator can ensure the profit-maximizing number of retailers $\hat{r}^i$ by charging a corresponding store rent $\hat{p}_r^i$, which satisfies $\hat{r}^i = \phi^i(\hat{v}^i, \hat{p}_r^i)$.[6] Equations 4, and especially 5, demonstrate that the operator of shopping mall i chooses to serve the number of retailers that maximizes the joint surplus of the mall's visitors and the mall, whereas the interests of the multi-homing retailers are not taken into consideration. This implies that the mall operator attaches more importance to the pricing of parking than to the pricing of shop areas.

We can specify equation 5 as

$$\hat{v}^i \cdot \alpha_v \cdot r^i + \hat{v}^i \cdot b \cdot (1 - r^i) \cdot r^i - c_v^i \cdot \hat{v}^i + c_r^i \cdot r^i. \tag{6}$$

Maximizing equation 6 with respect to r^i yields

$$\hat{r}^i = \hat{r}^i(\hat{v}_i) = \frac{(b + \alpha_v) \cdot \hat{v}^i - c_r^i}{2 \cdot b \cdot \hat{v}^i}, \tag{7}$$

which the operator of mall i can ensure by charging a store rent of

$$\hat{p}_r^i = \hat{p}_r^i(\hat{v}_i) = \frac{c_r^i + (b - \alpha_v) \cdot \hat{v}_i}{2}. \tag{8}$$

To calculate the number of mall i's visitors, we use

$$\hat{v}^i = \tilde{x} = \frac{1}{2} + \frac{\alpha_v \cdot \left[\hat{r}^i(\hat{v}^i) - \hat{r}^j(1 - \hat{v}^i)\right] + \hat{p}_v^j - \hat{p}_v^i}{2t}. \tag{9}$$

Unfortunately, it is impossible to determine an explicit function for the equilibrium number of visitors when inserting equation 7 into equation 9. But as our model is symmetric, $\hat{p}_v^i = \hat{p}_v^j$ holds in equilibrium and as a consequence, $\hat{v}^i = \hat{v}^j = 1/2$. By implicitly differentiating equation 9 and assuming a symmetric equilibrium, we obtain

$$\left.\frac{dv^i}{dp_v^i}\right|_{\hat{p}_v^i = \hat{p}_v^j} = -\frac{1}{2 \cdot [t - \alpha_v \cdot \hat{r}^{i\prime}(1/2)]}. \tag{10}$$

[6] If the mall operator sets the quantity of retailers (and not the rental price), the analysis yields the same result.

The profit of mall i as a function of p_v^i is

$$\pi^i = [p_v^i - c_v^i] \cdot v^i(p_v^i) + [p_r^i(v^i(p_v^i)) - c_r^i] \cdot r^i(v^i(p_v^i))$$

resulting, in general, in a profit-maximizing parking fee of

$$\hat{p}_v^i = c_v^i - \frac{v_i}{d\hat{v}^i/dp_v^i} - \hat{r}^i \cdot \frac{d\hat{p}_r^i}{dv^i} - [\hat{p}_r^i - c_r^i] \cdot \frac{d\hat{r}^i}{dv^i}. \tag{11}$$

In a symmetric equilibrium, it is

$$\hat{p}_v^i = c_v^i + t - [\hat{p}_r^i(\hat{v}^i) - c_r^i + \alpha_v] \frac{d\hat{r}^i}{dv^i}\bigg|_{\hat{v}^i=\frac{1}{2}} - \hat{r}^i(v_i) \frac{d\hat{p}_r^i}{dv^i}\bigg|_{\hat{v}^i=\frac{1}{2}}. \tag{12}$$

In a Hotelling model without cross-group externalities, the equilibrium price for consumers is the sum of the marginal costs of the mall to produce a parking space c_v^i, plus the Hotelling markup t. In the two-sided market model, however, we have two additional terms, because the mall operator internalizes the cross-group externalities. The third term of equation 12 describes the effect that the indifferent visitor of mall i has on the mall and its visitor side. The indifferent consumer's decision to visit mall i leads to an increase in the number of the mall's retailers. Through an additional retailer, the mall operator realizes $\hat{p}_r^i(\hat{v}^i) - c_r^i$ and the mall's visitors gain α_v. The fourth term of equation 12 describes the effect that the indifferent visitor of mall i has on the retailer side. As a result of the indifferent consumer's decision to visit mall i, its mall operator charges a higher rent that all retailers in the mall have to pay.

PROPOSITION 1: *If $b > \alpha_v$, a suburban mall charges a parking fee less than the Hotelling fee $c_v^i + t$.*

Proof: See Appendix.

Recall that we have assumed the variable profit per customer α_r to be uniformly distributed in a $[0, b]$-interval. Therefore, a large b means that customers are the source of high variable profit for some retailers. The mall operators do not know the type of a retailer, but expects it to be $b/2$ if no shop rent is charged. The average shop then earns $b/2$ per customer. In equilibrium, all retail chains $\alpha_r \in [\hat{p}_r^i/\hat{v}^i, b]$ open a shop in mall i. Thus, the expected type (retailer's benefit per customer) is at least $b/2$.

A consumer's benefit (or utility) gained from each shop is α_v.[7] In equilibrium, however, each mall is visited by half of the consumers. Apart from this, because of $v_0 + v_1 = 1$, the average number of visitors $(v_0 + v_1)/2$ is also $1/2$. An additional shop in a mall is the source of an additional utility of $\alpha_v/2$. To summarize, if the consumer-to-shop externality b is larger than the shop-to-consumer externality α_v, the mall tries to get the group with the higher cross-group externality - the consumers - on board by charging a reduced parking fee.

[7] With α_v being constant, we model the consumers' love for variety as a linear increasing function of the number of shops operating at a mall. If it is modeled by a concave function $\tilde{\alpha}_v(r)$, the suburban mall would subsidize parking when $b > \alpha_v(\hat{r}^i)$. Because $\alpha_v > \alpha_v(\hat{r}^i)$, the probability that a mall subsidizes parking is even larger.

PROPOSITION 2: *It holds*

$$\frac{\partial \hat{p}_v^i}{\partial c_v^i} > 0, \frac{\partial \hat{p}_v^i}{\partial t} > 0, \frac{\partial \hat{p}_v^i}{\partial b} < 0, \frac{\partial \hat{p}_v^i}{\partial c_r^i} > 0 \text{ and } \frac{\partial \hat{p}_v^i}{\partial \alpha_v} > 0. \tag{13}$$

Furthermore, if

$$b \geq 2c_v^i + 2t + \sqrt{4\left[c_r^{i2} + [c_v^i + t]^2\right] - 8c_r^i\alpha_v + \alpha_v^2}, \tag{14}$$

or equivalently if

$$c_v + t \leq \frac{b}{4} - \frac{4c_r^2 - 8c_r\alpha_v + \alpha_v^2}{4b}, \tag{15}$$

suburban malls do not charge for parking.

Proof: See Appendix.

The right-hand side of 15 is equal to the third and forth term of the right-hand side of 12, thus describing the effect that the indifferent visitor of mall i has on the utility/profit of all agents. It becomes clear that the subsidized parking fee is non-positive, if this effect is positive and exceeds the Hotelling fee in the absence of cross-group externalities $c_v + t$. The right-hand side of 15 is positive if $\alpha_v < 1$ (see Appendix). Parking is subsidized if $\alpha_v < b$ and if $b > 1$, subsidized parking is free if the marginal costs of parking and transport are low.

Furthermore, transport costs per unit distance in a spatial model like ours are related to the intensity of competition for visitors between the malls. Thus, the lower the transport costs per unit distance, the fiercer the competition. To summarize, if transport costs and the opportunity costs of providing parking are low, internalizing cross-group externalities c.p. more readily adjusts fees to zero.

C. Discussion

In our model, we assumed that retailers multi-home, thus running shops at both of the competing malls, and that consumers single-home, thus visiting only one of the two malls.

An alternative homing strategy could be single-homing on both market sides. Basically, the analysis that leads to market equilibrium works as in the case of a competitive bottleneck, whereby the retailing side is taken into consideration like the consumer side (Armstrong, 2006). The operator of a mall subsidizes parking if the benefit a consumer causes on the retailing side exceeds the per unit transport cost a consumer bears. But an equilibrium with single-homing on both sides only exists if some rather unrealistic conditions are fulfilled. First, the cross-group externalities have to be small, compared to the transport costs of visitors and retailers. Second, both retailers and customers must not deviate from single- to multi-homing. This is unrealistic, because if retailers run a shop in one mall only, they only reach some of the consumers. But at least the shop that is indifferent between homing the malls could earn additional profits when also homing at the second mall. Consumers would also deviate from their single-homing strategy and visit both malls to enjoy the full variety of products. For a single-homing equilibrium to exist, there have to be exogenous barriers to multi-homing, which do not exist in reality.

The assumption of multi-homing on both malls would imply irrational behavior by the consumers. The malls' shop quantity and variety is identical, so that by visiting both malls, more shopping opportunities do not arise, but the consumers' transport cost increases. However, there might be other model setups in which both retailers and at least some of the consumers multi-home. In a general model, Rochet and Tirole (2003) show that an exogenous increase in the multi-homing index of buyers results in an increase in the price charged to buyers and a decrease in the price charged to sellers.

Furthermore, all consumers in our model use cars for visiting the malls. The difference between the parking fee and the marginal costs of providing a parking space is therefore equivalent to an entrance fee. If consumers arrive by public transport, they do not need a parking space. If the mall wants to subsidize consumers due to high consumer-to-shop externalities, the mall could subsidize public transport, or offer subsidized or free tickets for public transport, or offer a (subsidized) shuttle service. Furthermore, if there is congestion on the mall's parking lot or on the streets leading to the mall, or if public transport is crowded, the mall could internalize congestion and crowding externalities by adjusting the parking fees and public transport subsidies. Ersoy et al. (2016) investigate a mall that sells products and internalizes the congestion externalities by raising the price of the products and subsidizing the parking fee. Because, in their approach, there are no cross-group externalities, congestion is necessary to induce subsidized parking. In our model, congestion in public transportation is not necessary, but would increase the probability of the mall operator offering free parking.

Hasker and Inci (2014) explain free parking assuming risk-averse customers and search costs. They assume that the probability of finding a product is exogenous, so that there is no shop-to-consumer externality. If we included searching in our model, we would assume that the probability of finding the product increases with the number of shops in the mall, which is a shop-to-consumer externality. The more shoe searching consumers visit a mall, the more attractive it becomes for shoe shops. Thus, by internalizing the externalities, mall operators might offer free parking even when consumers are risk neutral.

III. Parking fees at German shopping malls

Without knowing the exact values of the parameters in our model, we do not know whether condition 14 holds. However, given that our model depicts reality approximately, our own investigations regarding parking prices charged at suburban and urban malls in Germany, which are summarized in Table 1, suggest that this is mainly the case.

Table 1—Free or metered parking at (sub)urban malls

Number of malls		thereof: suburban malls		thereof: urban malls	
100		47		53	
Free Parking	Parking Fees	Free Parking	Parking Fees	Free Parking	Parking Fees
46 (46%)	54 (54%)	42 (89.4%)	5 (10.6%)	4 (7.5%)	49 (92.5%)

We have classified the investigated 100 largest German malls as "suburban", when we could not identify another reason to use their parking premises than to visit the malls. According to this classification,"urban" malls are those whose parking premises are also of use for people who have no (primary) intention to visit the mall. We thus follow Hasker and Inci (2014), as mentioned in the introduction. Note that the investigated malls either operate their parking garages or car parks on their own or have engaged another company as the operator.

Of the suburban malls, 42 out of 47, thus almost 90%, offer free parking to their visitors. The suburban malls where parking is not free of charge are located in Germany's large cities Hamburg (ELBE-Einkaufszentrum), where only the first hour is free, Frankfurt (NordWestZentrum and Hessen-Center), Munich (Riem Arcarden) and Nuremberg (Franken-Center).

Parking at urban malls is metered in 49 of 53 cases, thus in more than 92%. The urban malls that do not charge their visitors for parking are located in Eisenhüttenstadt (CityCenter), Chemnitz (SachsenAllee) and Ulm (Blautal-Center), which are relatively small towns, as well as in Oberhausen (Bero-Zentrum), where also the CentrO, one of Germany's largest malls with free parking, is located. Most of the urban mall parking fees are proportional to the time the parking space is used, but we also detect two types of price differentiation. In 19 of the 54 malls where visitors arriving by car have to pay for parking, the parking fees can be reduced by buying a so-called "Parkwertkarte", a quantity discount. This is a card that users of the malls' parking capacities can buy for a certain amount of money, say 25 €, or which they can top up by self-chosen amount of money. When paying the parking fees with the card, a discount of usually 10% is given. Furthermore, in 2 of the 54 malls, a few of the malls' retailers provide free parking to their customers for a certain time period. For example, customers of the electronics retailer Saturn located in the Spandau Arcarden in Berlin can park 60 minutes for free from a purchase value of 30 € upwards. This can be interpreted as a single retailer's attempt to keep pace with rivals operating at suburban malls in competition for consumers using the car. Furthermore, it is a form of third degree price discrimination between car drivers and pedestrians (Flores and Kalashnikov, 2017).

IV. Urban malls

From a two-sided market perspective, urban shopping malls are quite different to suburban malls. The main difference is that if individuals are able to free ride on the mall's subsidized parking spaces, as residents and tourist in a city are indeed able to do, and there is no oversupply of free parking, then free parking is not a viable strategy for a mall (Hasker and Inci, 2014), even if the mall would like to subsidize its visitors. Furthermore, an urban mall not only competes with other malls, which may conform to our assumption of a duopoly of malls, but with nearby shopping streets that are not managed like a mall. Visitors in an urban shopping district usually shop at the mall as well as nearby in street-located stores, i.e. urban consumers multi-home. Retailers single-home, because they expect consumers to visit their store.

Usually, there is a competitive market for retail space and the rent is competitive, differentiated according to quality. Therefore, urban malls neither provide exclusive access to customers (customers are multi-homing) nor to retail space (because there is competition between many retail space suppliers). The cross-group effect is thus between customers and the whole city.

If city planners and business operators fear that the city center is no longer an attractive shopping destination for consumers, parking fees are often one of the policy options considered. This is easily explained by our suburban mall model. Competing cities are similar to competing suburban malls. Consumers usually single-home and visit one city center only. Especially retail chains multi-home and open stores in all (attractive) cities. Cities are able to subsidize parking by offering low fees or even free parking. The difference with respect to the suburban mall is that the city government (as the platform operator) does not sell access to the city by renting retail space, but gains only indirectly from additional shops through higher tax revenue, more jobs and higher prices of land. Furthermore, the city government does not act as a mall operator which maximizes the mall's profits, but also considers the interests of residents (Molenda and Sieg, 2013; De Borger and Russo, 2017). However, especially smaller cities competing with larger cities may opt, as a suburban mall, to offer free parking to attract customers, thereby compensating for a smaller variety of products, even if the free parking strategy involves cruising for parking problems (Shoup, 2005; Arnott and Inci, 2006; Calthrop and Proost, 2006; Arnott and Rowse, 2009; van Ommeren et al., 2012).

V. Conclusion

A shopping mall is a platform in a two-sided market that internalizes the cross-group externalities between its visitors and retailers. One of the results of the internalization may be subsidized, or even free parking. Subsidized parking in shopping malls has been used to exemplify the theory of two-sided markets since the seminal papers of Rochet and Tirole (2003) and Armstrong (2006). Subsidized or even free parking can be optimal from a suburban shopping mall's point of view, both when the mall has monopoly power and when it competes with other malls. In the case of a monopolist shopping mall or of competing malls with single-homing on both market sides, however, subsidized or even free parking is one of many possible equilibria. By analyzing a spatial model of mall competition with single-homing on the consumer side and multi-homing on the retailer side, which are reasonable assumptions for shopping malls in medium-sized or large cities, we have been able to identify conditions for subsidized and free parking in suburban malls. If the consumer-to-shop externality is larger than the shop-to-consumer externality, parking fees are reduced. If consumers are very valuable to retailers, because they generate high variable profits, suburban shopping malls even offer free parking.

Urban malls, however, are different. Free riding of parking spaces often makes free parking infeasible. However, competition between small cities that fear a loss of attractiveness for consumers and retailers in terms of opening stores, can be analyzed with our approach. Such cities may opt for free parking as a strategy for revitalizing their shopping district.

Appendix

Proof of Proposition 1

It is

$$\hat{r}^i(v_i) = \frac{[b+\alpha_v]\cdot v_i - c_r^i}{2\cdot b\cdot v_i} \text{ and } \frac{d\hat{r}^i}{dv^i} = \frac{c_r}{2\cdot b\cdot v_i^2}. \tag{A.1}$$

Assuming that $\alpha_v > 2\cdot c_r^i$, $\hat{r}^i(v_i) > 0$ holds. It is $d\hat{r}^i/dv^i > 0$. Furthermore, it is

$$\hat{p}_r^i(v_i) = \frac{c_r^i + [b-\alpha_v]\cdot v_i}{2} \text{ and } \frac{d\hat{p}_r^i}{dv_i} = \frac{b-\alpha_v}{2}. \tag{A.2}$$

If $b > \alpha_v$, $\hat{p}_r^i(v_i)$ and $d\hat{p}_r^i/dv_i$ are positive. Because $\alpha_v > 2\cdot c_r^i$ and $\hat{p}_r^i > 0$, the term $\left[\alpha_v + \hat{p}_r^i(1/2) - c_r^i\right]$ of equation A.4 is also positive. To summarize, all terms in

$$\left[\alpha_v + \hat{p}_r^i(1/2) - c_r^i\right] \left.\frac{d\hat{r}^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} + \hat{r}^i(1/2) \left.\frac{d\hat{p}_r^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} \tag{A.3}$$

are positive and therefore

$$\hat{p}_v^i = c_v^i + t - \left[\alpha_v + \hat{p}_r^i(v_i) - c_r^i\right] \left.\frac{d\hat{r}^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} - \hat{r}^i(v_i) \left.\frac{d\hat{p}_r^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} < c_v^i + t. \tag{A.4}$$

Proof of Proposition 2

Because

$$[\alpha_v + \hat{p}_r^i(1/2) - c_r^i] \left.\frac{d\hat{r}^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} + \hat{r}^i(1/2) \left.\frac{d\hat{p}_r^i}{dv^i}\right|_{\hat{v}^i=\frac{1}{2}} = \frac{b^2 - \alpha_v^2 - 4c_r^i\cdot[c_r^i - 2\alpha_v]}{4b}, \tag{A.5}$$

the mall charges

$$\hat{p}_v^i = c_v^i + t - \frac{b^2 - \alpha_v^2 - 4c_r^i\cdot[c_r^i - 2\alpha_v]}{4b}, \tag{A.6}$$

which is non-positive if

$$b \geq 2c_v^i + 2t + \sqrt{4\left[c_r^{i2} + [c_v^i + t]^2\right] - 8c_r^i\alpha_v + \alpha_v^2}, \tag{A.7}$$

or equivalently if

$$c_v + t \leq \frac{b}{4} - \frac{4c_r^2 - 8c_r\alpha_v + \alpha_v^2}{4b} =: \tilde{c}. \tag{A.8}$$

Conditions for a positive $\tilde{c}$ are $c_r < 1/2$ and $\alpha_v < 1$. Because of our assumption $c_r < \alpha_v/2$ this holds if $\alpha_v < 1$. Furthermore,

$$\text{(A.9)} \quad \frac{\partial \hat{p}_v^i}{\partial c_v^i} = \frac{\partial \hat{p}_v^i}{\partial t} = 1, \frac{\partial \hat{p}_v^i}{\partial b} = -\frac{b}{4} < 0, \frac{\partial \hat{p}_v^i}{\partial c_r^i} = \frac{c_r^i}{4} > 0 \text{ and } \frac{\partial \hat{p}_v^i}{\partial \alpha_v} = \frac{\alpha_v - 2c_r^i}{2b} > 0.$$

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