The Optimal Composition of Shopping Malls during the Ongoing Evolution of US Retail

April 9, 2018

Cheuk Shing Leung

PhD Candidate

Department of Economics

McGill University

(514) 851-8298

cheuk.s.leung@mail.mcgill.ca

Peng Liu

STB Distinguished Professor in Asian Hospitality
Management and Associate Professor in Real Estate

S.C.Jonhson College of Business

Cornell University

(510) 277-2960

peng.liu@cornell.edu

Tingyu Zhou

Assistant Professor

Department of Finance

John Molson School of Business, Concordia University

(514) 961-3991 ext. 2459

tingyu.zhou@concordia.ca

Abstract

We examine the tenant compositions of anchor stores non-anchor retail stores ,and specialty stores inside shopping malls during the ongoing evolution in the U.S. retail industry. We extend the existing theoretical framework to incorporate a broader definition of anchor stores of different types and to re-examine the trade-off between agglomeration and competition by locating together inside shopping centers. Our model predicts the optimal tenant composition as an equilibrium outcome through the profit maximization strategies made by both tenants and the landlord. Next, we empirically test our model with a novel dataset of a comprehensive list of tenants inside large-scale shopping centers in the US. Our model and empirical results help explain the entry and exit decisions by retailers, including both anchor stores and specialty stores, as well as valuation and investment implications for malls that have difference tenant compositions.

1 Introduction

The retail sector has seen dramatic changes and a massive restructuring. In Hortacsu and Syverson (2015), the future of the retail sector might be a "bricks-and-clicks" hybrid that combines the traditional "one-stop shopping" at physical stores and online shopping through e-commerce. The consequences and implications of the current retail trends on shopping malls are twofold. On the one hand, with a rapid growth of e-commerce, hundreds of malls have closed in recent years and more are struggling. On the other hand, a few malls were able to outperform its rivals by offering unique shopping experiences in a "millennial playground" to avoid price battles with e-commerce.[1] Therefore, the tenant mix of shopping centers, though different from the traditional way prior to the late 1990s, still plays a vital role as long as we expect that physical formats would remain a substantial factor in the retail sector. The objective of this research project is to improve existing theoretical framework and to provide empirical evidence on the "modern" way of optimal tenant composition inside shopping malls as an equilibrium outcome through the profit maximization strategies made by tenants and the landlord.

Our model is based on the trade-off between agglomeration benefits and competition costs from the incentives of two types of tenants, i.e. anchor stores and speciality stores, by locating together inside shopping centers. Anchor stores with well-known brand names receive rent subsidies from the landlord as well as from non-anchor specialty stores by creating positive externalities (Pashigan and Gould,

[1] A good example of "a millennial playground" is the Atlantic Mall in Atlanta GA, which "charges retailers about 20 percent over the market rate and rarely has vacancies." See http://www.marketplace.org/2016/11/30/business/mall-lures-customers-offering-experiences

1998 and Gould, Pashigan and Prendergast, 2005).[2] However, there exists fierce competition between anchor stores and non-anchor specialty stores selling similar and comparable goods (i.e. substitutes) (Konishi and Sandfort, 2003). In our empirical tests, we utilize a novel dataset on all the tenants inside a comprehensive list of large-scale shopping centers in the US. Based on our model, we empirically examine the optimal tenant mix given that the landlord maximizes revenue by managing the allocation of spaces among anchor stores and non-anchor stores.

Different from previous studies which restrict the anchor store being the traditional department stores selling a variety of merchandize, this paper develops a general equilibrium model based on a self-defined anchor store list for each shopping center. This broader definition of anchor stores allows different types of stores including fashion chains, digital stores, movie theatres or even art galleries to be a traffic-generating anchor, with which the owner aims to create unique in-store experiences with one-stop family shopping and entertainment. The traditional definition of anchor stores as department stores is no longer adequate with the surge of online e-commerce. If we broaden the concept of anchor stores to include a wider range of niche retailers (e.g. fashion chains and movie theatres), the trade-off between competition and agglomeration among anchor stores and specialty stores has to be revisited. Although the major role of an anchor store remains unchanged and is to attract consumer traffic, many anchor stores under the broader definition would no longer compete with the non-anchor specialty stores as described in previous studies.[3] We fill this void by categorizing non-anchor stores as either competing or non-competing with the anchors.

This study will draw meaningful implications on the future of the retail sector and makes several contributions. First, this is the first study on the co-location incentives between anchor stores and non-anchor stores during the ongoing revolution of the retail industry. The retail industry in the US has undergone enormous restructuring resulting in construction of new retail space, abandonment of nearby space, bankruptcies, mergers and acquisitions. Many large retail operators are divesting under-performing properties and once successful retailers such as Sears and JC Penney are now striving for survival. Our model and empirical results could help explain the entry and exit decisions by anchor stores and non-anchor specialty stores, as well as construction, destruction and rebuilding decisions by owners. Further, extensions based on our model incorporating shocks from macro-economy and the competition from e-commerce could help draw valuation and investment implications for malls that have different tenant composition.

[2] The presence of anchor stores increases the mall traffic by attracting shoppers who do not know their purchasing preferences. Lesser-known specialty stores can free ride off the reputation of well-known anchor stores. Thus, specialty stores are willing to pay higher rents by locating near anchors.

[3] For example, a movie theatre as an anchor would not compete with any of the other stores in the same mall.

Second, this paper is one of the rare studies that incorporate the owner's incentives. Most of prior studies ignore the owner's incentives and focus only on decisions made by customers and retailers (e.g. Stahl, 1982; Wolinsky, 1983).[4] The very few existing studies on tenant composition within shopping centers ignore the owner's decision on the variation of competition among anchor stores and non-anchor stores (Benjamin, Boyle and Sirmans, 1992; Brueckner, 1993; Konishi and Sandfort, 2003). Third, the existing empirical research on tenant mix within shopping centers is scant. Due to data limitations, most of papers are theoretical in nature.[5] Among Most of the existing empirical studies on shopping mall tenants focus only on anchor stores (Vitorino, 2012; Shanmugam, 2013; Zhou and Clapp, 2015 and Zhou and Clapp, 2016). The limitation of focusing only on anchor stores is that it ignores the agglomeration and competition between anchor stores and non-anchor stores, and the profit maximization by the owner, the key decision maker on lease contracts within shopping centers.

In summary, the objectives of this research are to examine the following questions: (1) Theoretically, what are the relations among spaces allocated to the three types of tenants (i.e. anchor stores, competing non-anchor stores and noncompeting non-anchor stores) and the owner's profit? (2) Empirically, do our data support prediction of optimal tenant mix established in the theoretical model? (3) What valuation and investment implications could we draw based on malls that have difference tenant compositions? And what economic and policy implications would help us better understand the ongoing evolution of US retail resulting in the optimal tenant mix in "the playground for the millennial"?

Our major data source for this study is CoStar, the largest and most comprehensive database of commercial real estate in the US. The sample was collected when one of the authors was visiting at the University of Connecticut in 2016. We obtain a cross-sectional sample of over 1,200 regional and super regional malls in the US as of 2016. CoStar provides detailed information on property and locational characteristics.

For each mall, CoStar provides a comprehensive list of tenants. Tenant-level information includes the name of the store, SIC code of the retailer, gross leasable areas (GLAs) and whether the store is classified as an anchor store in the mall. Most important, we will be able to construct a proxy for the owner's profit per square footage based on property assessment values. When the market is at

[4]Some studies analyze co-location of stores based on game theory such as Hotelling-type models (see Gehrig, 1998; De Palma, Ginsburgh and Papageorgiu, 1985; Anderson, de Palma and Thisse, 1992; Konishi, 2005), and consumers' sequential search models (see Diamond, 1971, Wolinsky, 1986, Anderson and Renault, 1999 and Fischer and Harrington, 1996). These studies do not model explicitly the co-location between anchor stores and non-anchor stores within shopping centers.

[5]West (1992) finds evidence of store brand proliferation within shopping centers by multichain firms that operate stores catering to comparison shoppers. Pashigan and Gould (1998) and Gould, Pashigan and Prendergast (2005) find that anchors pay significantly lower rent than specialty stores and that the space allocation is efficient as the total sales from an additional square foot of anchor space are equal to those from an additional square foot of specialty space. However, these studies ignore the competition between anchors and non-anchor specialty stores.

equilibrium, the owner chooses a combination of anchor store and non-anchor stores to maximize her profit, given the constraint on the mall size. We will empirically test the profit maximization problem based on the theoretical framework by using the proxy for the owner's profit, the GLA ratio of anchor to competing specialty stores and the GLA ratio of anchor to non-competing specialty stores, controlling for the physical and locational characteristics of the mall.

2 Model

We model a representative shopping mall. The mall owner maximizes total profit by choosing the optimal number and combination of tenants at her shopping center. There are three types of tenant stores: an anchor store, non-anchor retail stores and non-anchor specialty stores. We assume that there are k_1 number of non-anchor retail stores each of which sells different types of non-substitutable products i. The anchor store also sells same types of merchandise i but they are not identical to those selling in the non-anchor retail stores. For example, anchor store sells with famous brand names like Nike, Adidas while non-anchor retail stores sell shoes with lesser-known brand names. Hence there is a direct competition between non-anchor retail stores and anchor but no competition across retail stores selling different types of products since different merchandise types are non-substitutable with each other. For tractability, the substitutability of each merchandise is assumed to be the same for all $i = 1, 2, ..., k_1$. Therefore we can solve the profit maximization problem with a representative non-anchor retail store selling merchandise i and the anchor store jointly. By symmetry, the solution holds for all other products i. Our model is flexible to extend with heterogeneous competitiveness if necessary.

In addition, we assume that there are k_2 number of specialty stores selling different types of non-substitutable goods relative to the anchor store but small internal competition exists among themselves. The limited purchase amount of specialty goods gives rise to the competition among the specialty stores. Also, all the specialty stores will affect each other and this is contrast to the case of anchor and non-anchor retail stores where non-anchor retail stores selling a particular merchandise i will not have any competion with other non-anchor retail stores selling merchandise $j \neq i$.

Marginal costs of production by the anchor store are normalized to zero, while the marginal costs of the non-anchor retail stores and specialty stores are constant at the common value $c_s > c_r > 0$, respectively. Any type i merchandise prices are given by p_i for non-anchor retail stores $i = 1, ..., k_1$, by p_i^A for the anchor store and by p_s for the specialty stores. There is a continuum of consumers who have identical preferences but differ in their distances to the shopping centre and so do their transportation cost t, known to the consumers. The cost t ranges from 0 to T to reflect the senario that consumers are uniformly distributed in a circle with radius T and the mall is located at centre.

The closest work on the theoretical part is the paper by Konishi and Sandfort (2003), in which consumers are assumed not knowing the prices of the merchandise before visiting a shopping centre, while they only know the product price at the anchor store. However, in our model, we allow the merchandize and their prices at both anchor stores and non-anchor stores to be a common knowledge by consumers before visiting the mall. The popularity of online shopping enables consumers to realize their values of visiting a shopping centre in advance. That is, consumers are informed about how much they like the merchandise sold by any kinds of the stores in the shopping mall.

In addition to the anchor stores and non-anchor retail stores, there are some specialty stores located in a shopping mall, for example, souvenir stores, pet stores and restaurants. These stores have no direct competition with the anchor and non-anchor retail stores since they sell relatively unique products or services. However, they have minor competition among themselves. For instance, visitors in the shopping mall may want to buy some souvenirs and they have to purchase it in those specialty stores. The inclusion of specialty stores enriches our model to capture a more realistic configuration of a shopping centre.

The profit-maximizing mall owner chooses a combination of tenants (k_1, k_2) and rents (r^A, r_i, r_s) taking those stores' outside option values into consideration. Anchor store, non-anchor retail stores and specialty stores have reservation profits ρ^{anchor}, ρ^{retail} and $\rho^{specialty}$, respectively. These profits determine rent ceiling for the tenants in order to keep them to stay in the mall. The rent plays an important role in choosing optimal composition because it should be part of the cost that influence stores' pricing decision. In other word, mall owner's rental decision will affect the profits of her tenants and, in return, mall owner needs to revise her rent in order to extract all the surplus from tenants. This process stops until the mall owner does not need to update the rent. In the literature, this is the first paper to use general equilibrium setting to capture this rent-updating procedure. In the real world, mall owners will revise the rent at the time of contract renewal. Konishi and Sandfort(2003) ignored this important element in their model setting and this paper provides a more sophisticated tool to study optimal mall configuration with rent-updating process.

The solution concept of this sequential game is the subgame perfect Nash equilibrium. The problem can be solved by backward induction and it is illustrated as follows.

2.1 The Consumer's purchase decision

The objective of consumers is to maximize their utility by choosing the number and combination of $2k_1 + k_2$ types of different merchandise in a shopping centre within their budget constraints. According to Dixit (1979), a system of demand functions for differentiated products can be obtained from optimizing the surplus of a representative consumer with a large enough budget:

$$\max_{\mathbf{q}} U(\mathbf{q}) - \sum_{i=1}^{2k_1+k_2} p_i q_i$$

U is assumed to be quadratic and strictly concave with all the parameters positive, $\beta > \epsilon$; $\mathbf{q}$ is a vector of consumption choices from consumer with three tuples $\underbrace{k_1}_{\text{Anchor}} \times \underbrace{k_1}_{\text{Retail}} \times \underbrace{k_2}_{\text{Specialty}}$. We modified the utility function $U(\cdot)$ to a form of

$$U(\mathbf{q}) = \underbrace{\left(\sum_{i=1}^{k_1} q_i^A + \sum_{i=1}^{k_1} q_i + \sum_{s=1}^{k_2} q_s \right)}_{\text{preference for more quantity}} - \left[\underbrace{\frac{1}{2} \left(\beta \sum_{i=1}^{k_1} \left(q_i^A\right)^2 + \beta \sum_{i=1}^{k_1} q_i^2 + \sum_{s=1}^{k_2} q_s^2 \right) + \epsilon \sum_{i}^{k_1} q_i^A q_i + \frac{1}{2}\theta k_2^\alpha \sum_{s \neq -s}^{k_2} q_s q_{-s}}_{\text{preference for variety}} \right]$$

The partial derivative of the above utility function is finite which implies that the demand of a particular good can be zero if price is too high. Otherwise, if $U'(q) \to \infty \; as \; q \to 0$, then the demand of that particular goods must be strictly positive regardless of the price. The quadratic term of the disutility implies that the consumers love for variety. The disuiltiy can be minimized by consuming a variety of goods with smaller amount under the budget constraint.

The sign of ϵ determines whether the products are substitutes(positive), independent(zero), or complements(negative). When $\beta = \epsilon$, the products q_i^A and q_i are perfect substitutes. ϵ^2/β^2 measures the degree of competition between the anchor store and retail stores ranging from zero when the products are independent to one when the products are perfect substitutes or homogeneous. We use the degree of competition and product substituability interchangeably. In our model, the competition among the non-anchor specialty stores arises from the number of stores and the product substituability. Therefore, the degree of competition between non-anchor specialty stores is the multiplication of two components θ and k_2^α , where α is the competition elasticity of the number of specialty stores k_2 and θ measures the intensity of competition coming from the product substitutability.

Holding the substitutability θ equal, α measures how much the percentage change of competition comes from a 1% change in the number of stores. Similarly, holding the number of stores equal, θ measures the intensity of competition due to product substitutability. This functional form allows a more flexible measure of the degree of competition among non-anchor specialty stores and decomposes the effect into two different factors. To capture the preference over different kinds of product, we introduce a preference parameter β to the merchandise q_i^A and q_i and the one to q_s is normalized to be 1. When $\beta > 1$, consumers prefer more the consumption of q_s and $\beta = 1$ means the equal preference of all products. This model feature is novel to the literature as this can capture a time changes of consumer preference, which is a crucial element to space allocation of a shopping mall over time.

2.2 Pricing Functions

Anchor store sells k_1 number of commodities, each type of merchandise i faces a direct competition with non-anchor retail stores. Therefore, the price of merchandise i depends on its own quantity supply and the substitutes supplied by the non-anchor retail stores. Each type of merchandise has its own pricing function. In principle, there should be k_1 number of pricing equations for both anchor and non-anchor retail stores. For simplicity, we assume the degree of competition (value of ϵ) is identical across all commodities $i = 1, ..., k_1$. By symmetry, we only need to consider a particular merchandise i and it represents all other k_1 commodities. Since anchor store sells k_1 number of commodities, its profit will be the sum of the sale profit coming from all commodities $(\pi_1, ..., \pi_{k_1})$.

The pricing function for non-anchor specialty stores is more complicated since it takes all other non-anchor specialty stores into consideration but the interpretation is similar to that of the anchor store.

The first order condition of consumer optimization problem gives the corresponding pricing function for different types of stores:

1. Anchor store's pricing function for merchandise i

$$p_i^A = 1 - \beta q_i^A - \epsilon q_i \qquad i = 1, .., k_1;\;\; 0 < \epsilon < 1 \tag{1}$$

2. Non-anchor retail stores' pricing function for category i

$$p_i = 1 - \beta q_i - \epsilon q_i^A \qquad i = 1, .., k_1;\;\; 0 < \epsilon < 1 \tag{2}$$

3. Non-anchor specialty stores' pricing function

$$p_s = 1 - q_s - \theta k_2^{\alpha} \sum_{j \neq s}^{k_2} q_j \qquad s = 1, ..., k_2;\;\; 0 < \theta k_2^{\alpha} < 1 \tag{3}$$

The case of $\epsilon, \theta = 0$ represents a monopoly scenario in which all the products are independent and non-substitutable. Moreover, when $\epsilon, \theta k_2^{\alpha} = 1$, it means that the products are homogenous and they share the same price. In this paper, we focus on the case of anchor store, non-anchor retail stores and non-anchor specialty stores selling differentiated products ($0 < \epsilon, \theta k_2^{\alpha} < 1$) in a mall. Our goal is to study how the degree of competition affects the equilibrium tenant composition and rents per sale for different types of stores in a shopping mall.

2.3 Equilibrium Prices

We inverse the pricing functions derived from above to obtain the set of demand functions for anchor store, non-anchor retail stores and specialty stores as follows:

Anchor store's demand function of merchandise i

$$q_i^A = \frac{1}{\beta+\epsilon} - \frac{\beta}{\beta^2-\epsilon^2}p_i^A + \frac{\epsilon}{\beta^2-\epsilon^2}p_i$$

Non-anchor retail stores' demand function of merchandise i

$$q_i = \frac{1}{\beta+\epsilon} - \frac{\beta}{\beta^2-\epsilon^2}p_i + \frac{\epsilon}{\beta^2-\epsilon^2}p_i^A$$

Given the rents (r_i^A, r_i, r_s) for anchor store, retail stores and non-anchor specialty stores respectively, all types of stores choosing the equilibrium price strategies simultaneously.

Anchor chooses price p_i^A to maximize its profit of selling merchandise i:

$$\max_{p_i^A}\left(\frac{1}{\beta+\epsilon} - \frac{\beta}{\beta^2-\epsilon^2}p_i^A + \frac{\epsilon}{\beta^2-\epsilon^2}p_i\right)(p_i^A - r_i^A) \quad \forall i = 1, ..., k_1$$

$$p_i^{A*} = \frac{\beta-\epsilon+\epsilon p_i + \beta r_i^A}{2\beta} \tag{4}$$

Non-anchor retail stores choose price p_i to maximize profit of selling merchandise i

$$\max_{p_i}\left(\frac{1}{\beta+\epsilon} - \frac{\beta}{\beta^2-\epsilon^2}p_i + \frac{\epsilon}{\beta^2-\epsilon^2}p_i^A\right)(p_i - r_i - c_r)$$

$$p_i^{*} = \frac{\beta-\epsilon+\epsilon p_i^A + \beta(r_i + c_r)}{2\beta} \tag{5}$$

Solving equation (3) and (4) simutaneously, we have the equilibrium prices

$$p_i^* = \frac{(\epsilon + 2\beta)(\beta - \epsilon) + \beta\epsilon r_i^A + 2\beta^2(r_i + c_r)}{(2\beta - \epsilon)(2\beta + \epsilon)} \tag{6}$$

$$p_i^{A*} = \frac{(\epsilon + 2\beta)(\beta - \epsilon) + \beta\epsilon(r_i + c_r) + 2\beta^2 r_i^A}{(2\beta - \epsilon)(2\beta + \epsilon)} \tag{7}$$

Substituting these equilibrium prices into the demand functions, we have the following equilibrium quantities:

$$q_i^* = \frac{\beta\left[(r_i + c_r - 1)(\varepsilon^2 - 2\beta^2) + \beta\varepsilon(r_i^A - 1)\right]}{(\beta^2 - \varepsilon^2)(4\beta^2 - \varepsilon^2)}$$

$$q_i^{A*} = \frac{\beta\left[(r_i^A - 1)(\varepsilon^2 - 2\beta^2) + \beta\varepsilon(r_i + c_r - 1)\right]}{(\beta^2 - \varepsilon^2)(4\beta^2 - \varepsilon^2)}$$

Equilibrium profit for anchor equals to the sum of all types of merchandise i:

$$\begin{aligned} \Pi^{A*} &= \sum_{i=1}^{k_1} \pi_i^{A*} \\ &= \sum_{i=1}^{k_1} (p_i^{A*} - r_i^A) q_i^{A*} \\ &= \sum_{i=1}^{k_1} \frac{\beta\left[(r_i^A - 1)(\varepsilon^2 - 2\beta^2) + \beta\varepsilon(r_i + c_r - 1)\right]^2}{(\beta^2 - \varepsilon^2)(\varepsilon^2 - 4\beta^2)^2} \end{aligned}$$

Equilibrium profit for non-anchor retail stores selling a particular type of merchandise i:

$$\begin{aligned} \Pi_i^* &= (p_i^* - r_i - c_r) q_i^* \qquad i = 1, ..., k_1 \\ &= \frac{\beta\left[(r_i + c_r - 1)(\varepsilon^2 - 2\beta^2) + \beta\varepsilon(r_i^A - 1)\right]^2}{(\beta^2 - \varepsilon^2)(\varepsilon^2 - 4\beta^2)^2} \end{aligned}$$

Equilibrium price and quantity for non-anchor specialty stores require to solve a system of pricing functions (3) and the proof is provided in the appendix.

Non-anchor specialty stores choose price p_s to maximize the profit of selling merchandise s

$$\max_{p_s} (a - bp_s + d\bar{p}_s)(p_s - r_s - c_s) \quad \bar{p}_s = \sum_{i \neq s}^{k_2} p_i$$

$$p_s^* = \frac{1}{2b + d}(b(r_s + c_s) + a + k_2 d\bar{p}) \quad \bar{p} = \frac{1}{k_2}\sum_{s=1}^{k_2} p_s^* \tag{8}$$

where $a=\frac{1}{1+(k_2-1)\theta k_2^{\alpha}}$, $b=\frac{1+(k_2-2)\theta k_2^{\alpha}}{(1+(k_2-1)\theta k_2^{\alpha})(1-\theta k_2^{\alpha})}$, $d=\frac{\theta k_2^{\alpha}}{(1+(k_2-1)\theta k_2^{\alpha})(1-\theta k_2^{\alpha})}$

The corresponding equilibrium quantity is

$$q_s^* = \frac{b\left[a(2b-d(k_2-3))+\bar{r}_s d(d-b(k_2-2))+b(d-2b)(r_s+c_s)\right]}{4b^2-d^2} \qquad \bar{r}_s=\frac{1}{k_2}\sum_{s=1}^{k_2} r_s$$

Equilibrium profit for non-anchor specialty stores selling a particular type of merchandise $s=1,...,k_2$:

$$\begin{aligned}\Pi_s^* &= (p_s^*-r_s-c_s)q_s^* \\ &= \frac{b\left[2ab+ad(k_2-1)+bd(k_2\bar{r}_s-r_s)-2b^2r_s+d^2r_s\right]\left[a(2b-d(k_2-3))+\bar{r}_s d(d-b(k_2-2))+r_s b(d-2b)\right]}{(d^2-4b^2)^2}\end{aligned}$$

2.4 Equilibrium Market Size

In this section, we consider consumers' decisions about whether to visit the mall. Given the fact that consumers know the equilibrium price set by the stores, consumers know their value surplus for visiting the mall:

$$\begin{aligned} V(q_i^{A*},q_i^*,q_s^*) \;=\; & \underbrace{\left(\sum_{i=1}^{k_1} q_i^{A*}+\sum_{i=1}^{k_1} q_i^*+\sum_{s=1}^{k_2} q_s^*\right)}_{\text{preference for more quantity}} \\ & -\left[\underbrace{\frac{1}{2}\left(\beta\sum_{i=1}^{k_1}\left(q_i^{A*}\right)^2+\beta\sum_{i=1}^{k_1} q_i^{*2}+\sum_{s=1}^{k_2} q_s^{*2}\right)+\epsilon\sum_{i}^{k_1} q_i^{A*}q_i^*+\frac{1}{2}\theta k_2^{\alpha}\sum_{s\neq -s}^{k_2} q_s^* q_{-s}^*}_{\text{preference for variety}}\right] \\ & -\underbrace{\left(\sum_{i=1}^{k_1} p_i^{A*}q_i^{A*}+\sum_{i=1}^{k_1} p_i^* q_i^*+\sum_{s=1}^{k_2} p_s^* q_s^*\right)}_{\text{Cost of purchasing}} \end{aligned}$$

Using the knowledge of equilibrium price $\mathbf{p}^*$ and quantitiy $\mathbf{q}^*$ computed in stage 3, consumers can determine whether or not to visit the mall. A necessary and sufficient condition for visiting requires the expected surplus from visiting greater than or equal to their transportation costs. We assume that consumers are distributed uniformly within a circle with radius T, which is the maximum transportation cost incurred. Hence only consumers located in the neighbour where their transportation costs t are less than or equal to value surplus $V(\mathbf{q}^*)$ will visit the mall. The population size going to the shopping mall

$\mu(\cdot)$ is given by

$$\mu(\mathbf{q}^*) \equiv \frac{\pi V(\mathbf{q}^*)^2}{\pi T^2} = \left(\frac{V(\mathbf{q}^*)}{T}\right)^2$$

2.5 Equilibrium Profits

By knowing the equilibrium profits from each consumer and the market size, we can determine the equilibrium profits for anchor, retail and non-anchor specialty stores:

$$\begin{aligned}\Pi^{anchor} &= \mu\Pi_A^* \\ \Pi_i^{retail} &= \mu\Pi_i^* \ \ \forall i = 1, ..., k_1 \\ \Pi_s^{specialty} &= \mu\Pi_s^* \ \ \forall s = 1, ..., k_2\end{aligned}$$

2.6 The profit-maximizing decision of the mall owner

Potential retail and anchor store tenants will accept the offer from the mall owner if and only if their net profits are not less than their outside option values ρ. Our model is sophisticated enough to provide a continuous measure of composition by giving the solution of optimal *shares* of area to be allocated to anchor, retail and non-anchor specialty stores. Compared to Konishi (2003) who can only provide a discrete measure of composition by giving the solution of optimal *numbers* of retail and anchor stores. The lack of information about size or area of the allocation makes their analysis incomplete. In this paper, we proxy the area or size of a store by its stock of merchandise i. More stocks put in a store, more space is required.

A mall owner chooses the number of types of merchandise to provide in the shopping centre in order to restrict the degree of competition. On the one hand, it is beneficial to include a variety of commodities in the mall in order to encourage larger consumer traffic since the consumers love for variety of purchases, but on the other hand the this incurs the cost of competition to the tenants, and hence rents have to be lower for compensation so does the profits to developer. Mall owner needs to make an optimal tradeoff between these two forces. Due to space limitation, we assume there is a maximum feasible number of merchandise types $(\bar{k}_1, \bar{k}_2)$ to be included in a shopping mall.

The mall owner's total rent revenue given any compositions of tenants is

$$\Pi^D(k_1, k_2) \equiv r^{anchor}(k_1, k_2) + \sum_{i=1}^{k_1} r_i^{retail}(k_1, k_2) + \sum_{s=1}^{k_2} r_s^{specialty}(k_1, k_2)$$

where r is the rent per sale charged to different stores. The land developer needs to guarantee that her tenants can obtain at least their reservation profit. Efficient rent extraction implies that any stores pay the rent such that

$$r^{anchor}(k_1, k_2) = \Pi^{anchor} - \rho^{anchor}$$

$$r_i^{retail}(k_1, k_2) = \Pi_i^{retail} - \rho_i^{retail}$$

$$r_s^{specialty}(k_1, k_2) = \Pi_s^{specialty} - \rho_s^{specialty}$$

ρ is the opportunity cost or the second highest value of contract provided by another shopping mall. The mall owner chooses the types of merchandise sold in the mall so as to maximize her rent revenue:

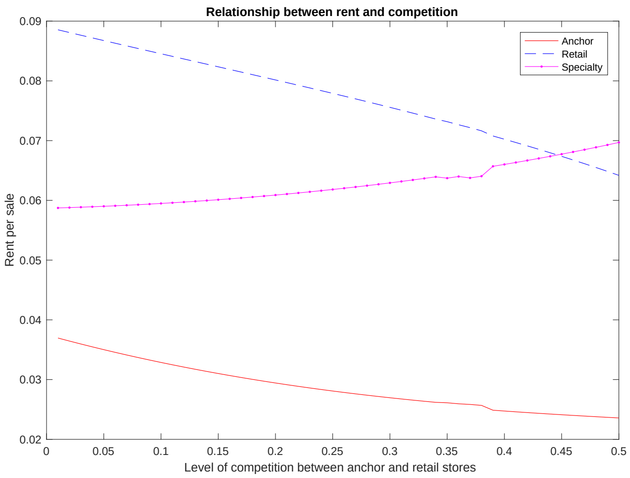
$$(k_1^*, k_2^*) = arg \max \Pi^D(k_1, k_2)$$

The equlibirum composition of tenants $(Q^*_{anchor}, Q^*_{retail}, Q^*_{specialty})$ is determined by (k_1^*, k_2^*):

$$\begin{aligned} Q^*_{anchor} &= \frac{\sum_{i=1}^{k_1^*} q_i^{A*}}{\sum_{i=1}^{k_1^*} q_i^{A*} + \sum_{i=1}^{k_1^*} q_i^* + \sum_{s=1}^{k_2^*} q_s^*} \\ Q^*_{retail} &= \frac{\sum_{i=1}^{k_1^*} q_i^*}{\sum_{i=1}^{k_1^*} q_i^{A*} + \sum_{i=1}^{k_1^*} q_i^* + \sum_{s=1}^{k_2^*} q_s^*} \\ Q^*_{specialty} &= \frac{\sum_{s=1}^{k_2^*} q_s^*}{\sum_{i=1}^{k_1^*} q_i^{A*} + \sum_{i=1}^{k_1^*} q_i^* + \sum_{s=1}^{k_2^*} q_s^*} \end{aligned}$$

The normalized solution of $(Q^*_{anchor}, Q^*_{retail}, Q^*_{specialty})$ gives us the optimal allocation rule.

2.7 Numerical Analysis



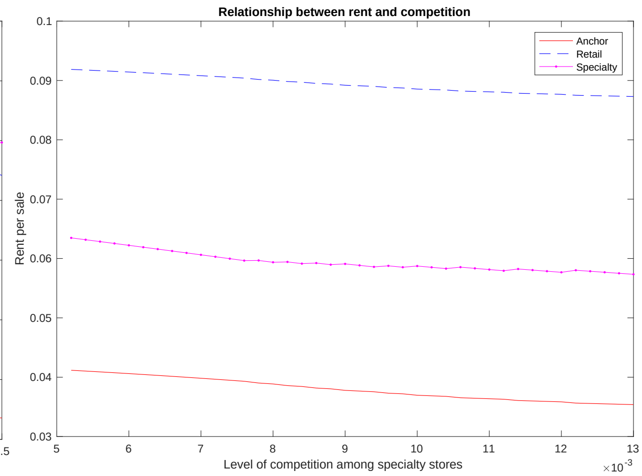
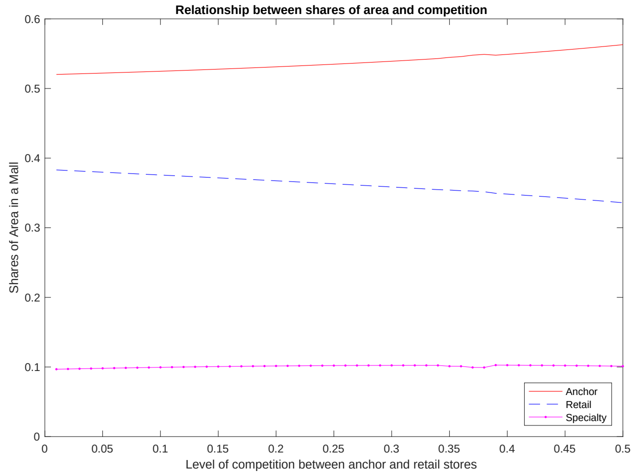


Figure on the left shows how the rent per sale varies with the degree of competition between anchor and non-anchor retail stores. As the level of competition increases, the rents of non-anchor retail stores and anchor decrease because the competition reduces their profits and hence the owner cannot charge a high rent on them. Instead, the owner will shift the cost of competition by charging a higher rent on non-anchor specialty stores who are free riding on the positive externality of the mall traffic. Same reason for why the non-anchor retail stores' rent is always higher than that of anchor store.

Figure on the right shows how the rent per sale varies with the degree of competition among non-anchor specialty stores. The main different is that the rent of non-anchor specialty stores decreases with competition which reduces their profits and hence the owner cannot charge a high rent on them to internalize the externality. Instead, the owner reduces the number of k_2 types of merchandise provided in the mall to minimize the cost of competition. There is a negative externality of limiting the variety of merchandise provided

as it lowers the consumers' surplus so does the mall traffic. As a result, both anchor and non-anchor retail stores suffer from the reduced volume of visitors and therefore their profits are affected. The owner has to lower their rent as well. This important implication is ignored in the literature as the group of non-anchor specialty stores are not included in other papers' model. In both cases, the rents for anchor are the lowest, which is consistent to the stylized fact.



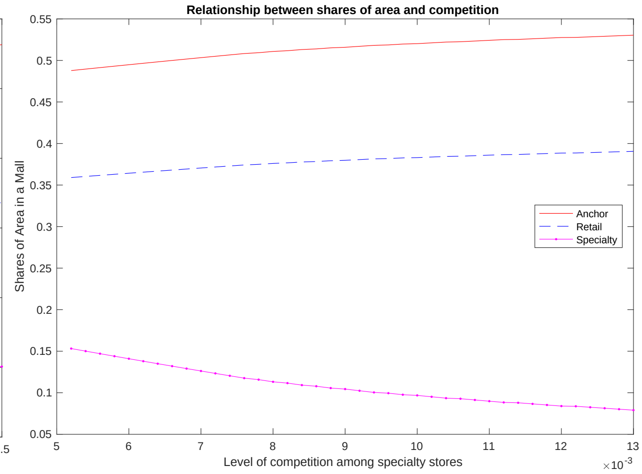
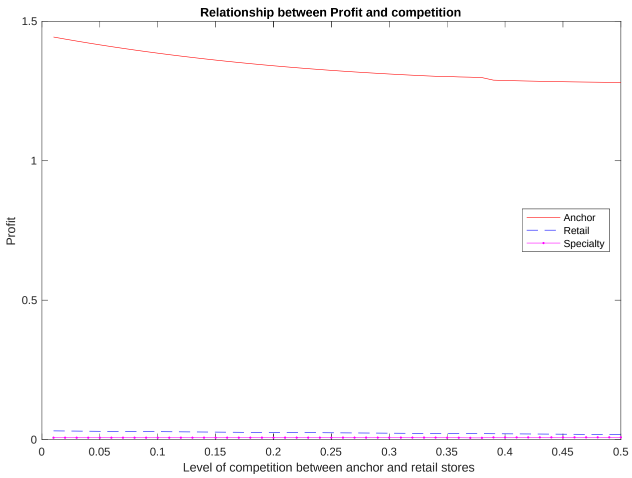


Figure on the left shows how the space allocation of different stores in a mall varies with the degree of competition between anchor and non-anchor retail stores. Given that the rents for anchor and non-anchor retail stores are lower when the level of competition is higher. The reduced rents imply a lower equilibrium price and hence more consumers are attracted to the mall because of lower prices. This means that the consumers get benefit from the increased competition betweem the anchor and retail stores. It is because the positive impact of increased mall traffic outweighs the cost of reduced rents, as a result, the owner should allocate more area to anchor in the expense of less area to retail stores. The allocation to non-anchor specialty stores almost unchange.

Figure on the right shows how the space allocation of different stores in a mall varies with the degree of competition among non-anchor specialty stores. The owner reduces the number of k_2 types of merchandise provided in the mall to minimize the cost of competition so the areas allocated to non-anchor specialty stores are transferred to anchor and non-anchor retail stores. This explains the increasing shares of area allocation for them.



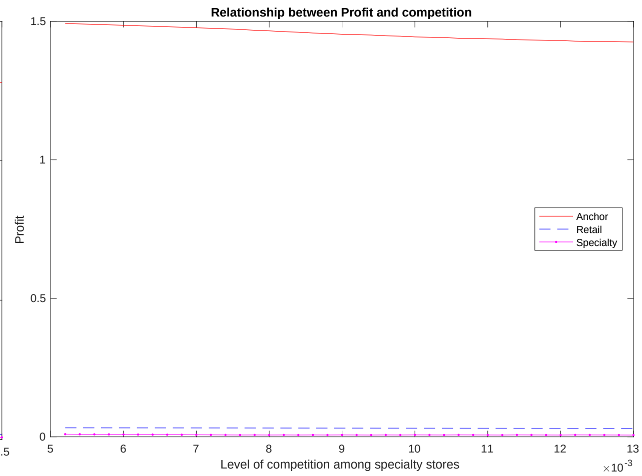
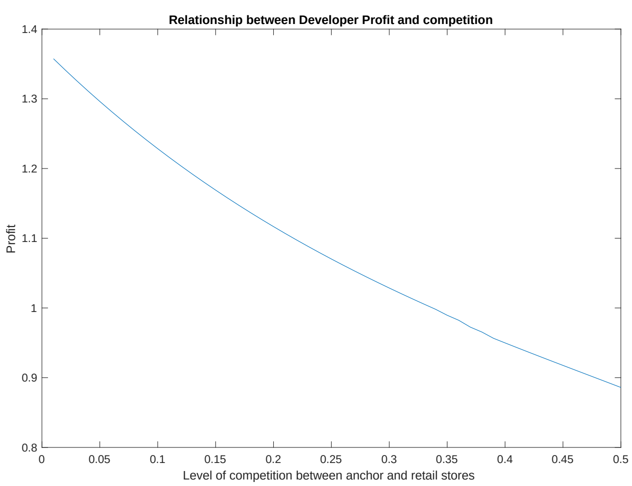
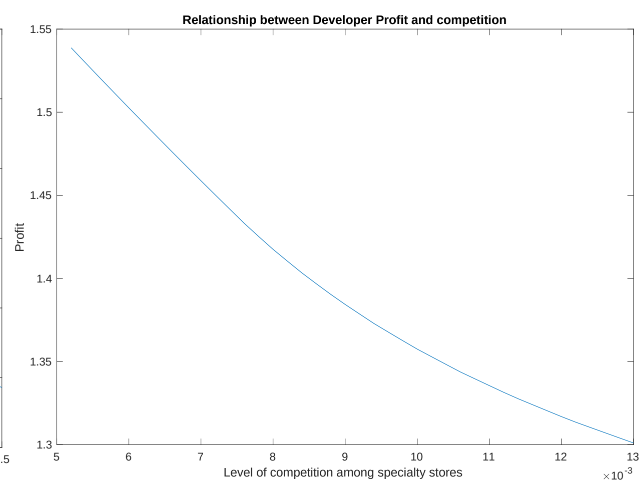


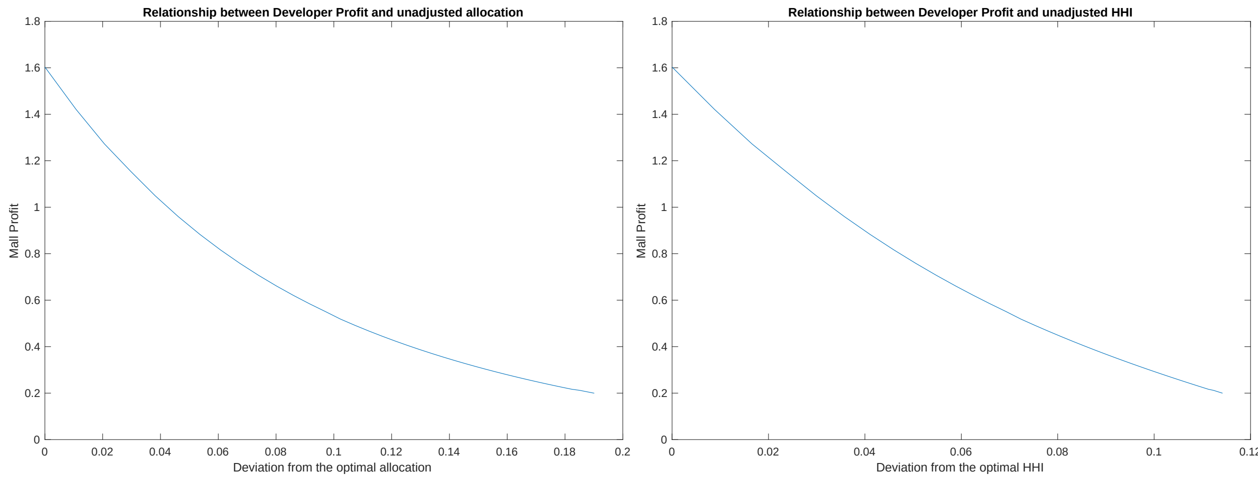
Figure on the left shows how the profits of different types of stores varies with the degree of competition between anchor and non-anchor retail stores. The anchor store suffers the most from negative impact of competion because anchor has to deal with the competition from all the product categories $i = 1, ..., k_1$ as assumed in our model while the retail stores only have to deal with their own product category i. This is the reason why there is only a minor decrease of profit to those non-anchor retail stores. In contrast, the non-anchor specialty stores enjoy a slightly increase of profit from their competition. It is because the increased consumer traffic generated by the higher competion exerts a positive externality to those non-anchor specialty stores.

Figure on the right shows how the profits of different types of stores varies with the degree of competition among non-anchor specialty stores. Not surprising that the profits of both anchor and non-anchor retail stores are not much affected since there is a negligible externality from the competion among non-anchor specialty stores.





Both figures show that the competition from either the non-anchor retail store and anchor or among non-anchor specialty stores reduces owner's profit convexly, which is consistent with our empirical estimations.



Tenants usually have to sign a long term contract for rental spaces with shopping mall owner and nothing can be changed during the contract period. However, consumers' preference over the type of products changes over time. They switched their preferences from anchor stores to specialty stores recently, so it is optimal for a shopping mall to reallocate the types of stores.
Unfortunately, the allocation cannot be adjusted in a short period of term due to the commitment of contract. It is necessary to evaluate how the shopping mall's revenue changes with deviation from the optimal allocation as if the owner can adjust the space allocation freely. The optimal space allocation to anchor stores decreases with the increasing preference toward specialty products. In other word, the allocation of anchor stores committed by the contract is larger than the optimal one it should be as time changes. This is reflected on the x-axis of the above graph. Figure on the left shows that the shopping mall revenue decreases with the deviation.
Similarly, when the optimal allocation to anchor has to be reduced with changing preference, the corresponding measurement of concentration (Herfindahl index) for anchor stores should also be decreasing. The x-axis shows its deviation from the optimal one as preference changes. Both predicted results by our model are consistent with our empirical findings.

3 Data

3.1 Sample Construction

The existing literature on empirical studies of shopping malls is scant due to the absence of data, in particular tenant-level and mall-level data.[6] The major dataset used in this project is CoStar, the largest and most comprehensive database of commercial real estate in the US.[7] We obtain a cross-sectional sample of over 1,200 large-scale malls in the continental US as of Q3 2016. Our sample covers a universe list of regional and super regional malls, with a typical gross leasable area (GLA) greater than 600,000 sq.ft. We focus on large-scale shopping centers because they are representative and of more economic importance. Most of regional and super regional malls are enclosed and with a standard format. Enclosed malls are costly to expand or contract (see Clapp, Salavei and Zhou, 2014). Most

[6] Gould et al. (2005) make use of detailed data but is restricted to a particular mall owner in limited geographic areas.
[7] The sample was collected when one of the authors was visiting at the University of Connecticut in 2016.

importantly, large-scale malls often have a standard format in which a significant proportion of spaces is allocated to the anchor stores. Together with the enclosed feature, the mall owner has a great incentive to maximize the total rental revenue through optimal space allocation. The collocation between anchor stores and non-anchor specialty stores fits our purpose of research on the trade-off between internalizing externality and competition.

CoStar provides detailed information not only on property characteristics, but also on tenant data of each mall. The mall level information includes center type, center name, address, year built, year of last renovation, number of levels, shape, number of stores, GLA, number of parking spaces and other features. CoStar provides a comprehensive list of over 160,450 tenants. Tenant-level information includes the name of the store, business type, GLA and whether the store is classified as an anchor store. [8] We have noticed that the anchor store status is mall-specific not tenant fixed feature. Therefore a tenant is an anchor for mall A while it is a non-anchor for mall B. One difficulty of our empirical work is to classify all the tenants into different categories in order to measure competition. Although Costar provides its own classifications of store types, such as department stores, home accessories, consumer electronics, supermarket etc., it is not standardized and a significant proportion of the classification is missing. [9]

We apply the North American Industry Classification System (NAICS) codes and design an algorithm to assign each tenant to its four-digit NAICS code. For tenants with non-missing store type defined by CoStar, we select the top ten tenants by number of counts and/or total GLAs within each store type. We manually check their NAICS codes, pick the 4-digit NAICS code with the highest frequency and assign that code to all the tenants with the same store type[10]. For example, for the CoStar-defined business type of "Department Store", the top-ten tenants include JC Penney (N=656), Sears (N=556), Macy's (N=389) etc. Most of these top-ten tenants have 4-digit NAICS code of "4521 – Department Stores". Therefore, we assign NAICS=4521 to all the tenants with business type of "Department Store"[11]. For the remaining tenants with missing store type, we apply web crawling methods and search for their NAICS codes on various websites such as siccode.com and manta.com. All the classifications are manually verified based on various sources such as the Gale and Hoover business reports[12].

[8]Information on number of employees, rents,lease term and other detailed lease features provided by CoStar is incomplete. We have decided not include in the our analysis

[9]Among our initial list of 160,450 tenants, there are 127 different store types. 14,628 (about 10%) of the tenants have missing store types.

[10]NAICS codes are check on https://siccode.com (last access: September 5, 2017)

[11]Another example is "Furniture/Mattress" defined by CoStar. The top ranked tenants include "Sleep Number" (N=216), "Mattress Firm" (N=64), "Love Sac" (N=51) etc. According to siccode.com, most of the tenants have 4-digit NAICS code of "4421 – Furniture stores." Therefore, we assign NAICS=4421 to all the tenants within the business type of "Furniture/Mattress".

[12]The Gale and Hoover business reports identify director competitors for some of the major retailers, especially depart-

The tenant composition expands to a variety of industries. Based on Hortaï¿œsu and Syverson (2015), the retail sector is defined as "retail trade" by the North American Industry Classification System (NAICS) as "engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise." Although most of the 4-digit NAICS sub-sectors belong to the retail trade industry (NAICS=44-45), some tenants are outside the retail trade industry. For example, offices for property leasing, real estate agency, banks and insurance companies belongs to NAICS sector 52-53. Travel agencies, recruitment and employment services are classified as NAICS sector 56.

3.2 Mall Performance: Proxy for Property Value, Rents and Vacancy

We do not have data on actual sales revenue and rents paid by tenants. To measure mall performance, we use the following five proxies: (1) log of total appraised value, (2) log of appraised value per sq. ft., (3) vacancy rate, (4) cap rate, and (5) log total rent. We include both total appraised value and appraised value per sq. ft. because of size effect. For example, smaller malls tend to command a higher value per square foot than larger malls. More important, we are interested in examining whether the effects of mall composition on these two outcome variables are different, depending on whether the owner maximizes the total value of the mall or simply value per square foot[13].

3.3 Mall Composition

We examine competition effect and agglomeration effect arising from mall composition using different measures. First, we construct two measures to assess the overall importance of anchors, percentage of anchor as total GLAs (% Anchor GLA) and percentage of anchor as total number of stores (% Anchor Store).

Second, we use Herfindahl-Hirschman indix (HHI) to measure concentration of businesses inside the mall. We calculate three different HHIs. HHI GLA is the HHI calculated by squaring the share of each tenant's GLA inside the mall. Other than individual tenant, we group GLA and number of stores by 4-digit NAICS code and calculate HHI (NAICS GLA) (HHI (NAICS #Store)) by squaring the share of each NAICS's GLA (number of stores). As robustness tests, for each method we construct HHI based on top-3 tenants or top-3 NAICS categories, including HHI GLA Top-3, HHI (Top3NAICS GLA), and

ment stores. For example, Saks and Bloomingdale's are the major competitors of Barneys New York. According to the Hoover report, Macy's competitors include Saks Fifth Avenue, Nordstrom, Dillard's and JC Penney. According to the Gale report, Macy's competitors are Dillard's, JC Penney and Saks. If one store is classified as a competitor of another, then both should belong to the same NAICS category.

[13] For each mall, CoStar reports vacancy rate. CoStar Analytics provides data on "NNN Rent Per SF" and "Cap Rate". However, over 70% of data is missing in our sample. In addition, this data might not be accurate as it is based on surveys in which rents were reported by tenants on a voluntary basis.

HHI (Top3NAICS #Stores). The higher the HHI concentration ratio , the higher the tenant competition level in the mall.

Lastly, we measure direct competition among anchors, between anchors and non-anchors and among non-anchors. The competition between anchors and non-anchors is asymmetric. Think of a mall with only two tenants, one anchor and one non-anchor, both selling the same type of product. The anchor occupies 70% of the spaces in the mall while the non-anchor takes the remaining 30%. From the anchor's perspective, competition from non-anchor is small. However, competition from anchor on the non-anchor is large. Therefore, we construct four types of competition: (1) competition from other anchors, given an anchor (% Anchor-Anchor); (2) competition from non-anchors, given an anchor (% Anchor-NonAnchor); (3) competition from other anchors, given a non-anchor (% NonAnchor-Anchor) and (4) competition from other non-anchors, given a non-anchor (% NonAnchor-NonAnchor). (1) and (2) are relative to anchor stores while (3) and (4) are relative to non-anchor stores. Similar to the previously mentioned measures, for each competition measure we calculate using GLA and number of stores separately. This leads us with eight measures in total summarized in Table 1.

We apply two different methods to identity competitors. In Method 1, we define tenants with the same four-digit NAICS code as competitors. Method 2 considers competition between "Department Store" (4-digit NAICS=4521) and other industries. Large, full-line department stores are the most common representatives of anchor stores (Vitorino, 2012; Gould et al., 2005; Zhou and Clapp; Ross, Clapp and Zhou, 2018). According to Hoover's Inc., a leading business information providers, major products sold by department stores include apparel (about 55% of US sales for the industry) and cosmetics, footwear and appliances (11%, 9%, and 5% of sales, respectively)[14]. Therefore we define department stores as competitors of "Clothing stores (NAICS=4481)", "Shoe stores (NAICS=4482)", "Jewelry, Luggage, and Leather Goods Stores (NAICS=4483)" "Health and Personal Care Stores (NAICS=4461)" and "Electronics and Appliance Stores (NAICS=4431)". Appendix 1 shows a simplified example.

When the market is at equilibrium, the mall owner/manager chooses the optimal composition of the mall, including number of stores, number of different business categories, percentage of spaces allocated to anchor stores, the trade-off between competition and agglomeration, given mall characteristics, demographical and economic characteristics, and outside competition. We will empirically test the profit maximization problem based on our theoretical framework.

[14] Apparel includes women's, men's, and children's clothing. Cosmetics include makeup, skin care, hair care, and fragrances. Appliances include refrigerators, stoves, washers, dryers, and dishwashers.

3.4 Mall Characteristics

CoStar provides detailed information on property characteristics. We construct a set of variables to capture the most important mall characteristics, including Size, building density, parking ratio, age, renovation and proximity to central business district (CBD). Size is proxied by log of total gross leasable areas (sq. ft.). The ideal measure of building density should be floor area ratio (FAR). However, this measure is often missing in our data so we use Number of levels. Parking ratio is calculated as number of parking spaces per GLA (in 1,000 square feet). Age is proxied by Year since built. Since a lot of malls were built in early years, we add a Renovation Dummy for the malls renovated within the past ten years.

We geocode the addresses and collect the latitudes and longitudes for all the malls using a geographic information system (GIS). We then use Haversine formula to calculate the distances to CBD. Distances based on Haversine formula are great arc distances instead of road distances. Road distances vary with topographical conditions and methods of transportation and hence are more difficult to measure. Zhou and Clapp (2015) find most of new anchor stores, as well as new malls, were opened in suburbs. This pattern reveals the profit maximization of malls when movements of population and income over the sample period have typically been away from the CBD and towards more outlying suburbs. We therefore follow Zhou and Clapp and include a set of variables to control for the suburbanization, which includes a CBD dummy for any location within five miles of the CBD (CBD 5 miles), distance of the location from the CBD (Distance to CBD) and distance squared.

3.5 Demographic Characteristics

Using the mall street addresses, we categorize the malls into different census tracts and counties based on "HUD USPS ZIP Code Crosswalk Files". Information is further verified based on various sources such as Google and GIS system. We locate each mall at the nearest tract or county centroid in order to avoid an infinite location choice set. We measure demographic and economic characteristics, including household density, density growth, median household income and household income growth, within 25-mile radius around the mall. We use 25-mile radius to measure household demographic characteristics based on the rationale of retail clustering and trade areas. For example, according to the International Council of Shopping Centers (ICSC) shopping center definitions, the primary trade area is 25 miles for super regional malls. Zhou and Clapp (2014) apply the Duranton and Overman (2005) K-density method to examine the spatial patterns of existing and new department stores. They find that about two thirds of the distances between existing stores fall within 25 miles. The results are robust to alternative distances such as 10 miles and 15 miles.

4 Result

Table 1 describes the variables collected and calculated from CoStar and the US Census. Our outcome variables include proxy for property value (total appraised value and appraised value per sq. ft.), vacancy, cap rate and rents. Our test variables include (1) anchor percentage (% Anchor GLA and % Anchor Store), (2) concentration of businesses inside the mall (six HHI measures) and (3) competition among anchors, between anchor and non-anchor and among non-anchors (eight competition measures). Our control variables include mall-level, locational, demographic and economic characteristics.

Table 2 presents summary statistics at the mall level. A typical mall in our sample is 38 years old, two-storey, 708,000 square feet of GLA, three anchor stores, 85 non-anchors, 5,000 parking spaces, renovated in the past ten years and located 7 miles from the nearest CBD. The average total assessment value is $52 million ($5.16 per square foot) as of 2015. Vacancy rates range from 0% to 29%. An average mall has a cap rate of 8% and generate $8.9 million as annual rental revenue. However, a large percentage of observations has missing information on cap rate and rent, which add constraints to our multivariate analyses.

Turning to mall composition, on average about 50% of mall spaces are devoted to anchor stores, consistent with Gould et al. (2005). However, only 6% of stores are anchors. Mean HHI based on GLA is 0.14, mostly driven by top 3 tenants (HHI Top3GLA = 0.12). When we group spaces and stores by NAICS, the mean HHI GLA (HHI #Store) is 0.28 (0.14). HHIs based on number of stores are smaller than those based on GLA, suggesting a higher diversification among stores than spaces.

From anchor stores' perspective, competitors that are also anchors occupy 32% of mall spaces (mean %GLA Anchor-Anchor = 0.32 based on Method 1). In contrast, competitors that are non-anchors occupy only 8%. From non-anchors' perspective, competitors that are anchors (non-anchors) occupy 20% (38%) of mall spaces. If we measure the total spaces between anchors and non-anchors regardless the perspective of competition, the mean %GLA is 28%. The average %GLA equals 82% among all competitors.

Competition measured based on number of stores is quite different from those based on GLA. Anchor competitors account for only 3% (2%) of the total tenants from the perspective of anchors (non-anchors). However, non-anchor competitors represent 8% (81%) for anchors (non-anchors). Together, anchor-to-anchor competition takes a large percentage of mall spaces due to its large size. But since there are few anchors, the competition becomes small if we count by numbers. The pattern of non-anchors is the opposite. Because they are small players the competition measured by GLA is not largely different from anchor-to-anchor. However, if we measure by numbers, over 80% of tenants are competing with each other. Competition between anchor and non-anchor is asymmetric: although anchors outbid non-anchors in space (0.08 versus 0.20 if we compare %GLA Anchor-NonAnchor with %GLA NonAnchor-Anchor), there are more non-anchor players that are in the same business as anchors (0.08 versus 0.02 if we compare %Store Anchor-NonAnchor with %Store NonAnchor-Anchor). These findings look intuitive simply due to size and numbers. However, there is a large variation in how owners divide mall spaces and allocate spaces to different players (anchor versus non-anchor) and to different business categories. For example, most of % Anchor GLA ranges from 8% to 75%, i.e., 5th to 95th percentile, repectively. The 25th percentiles suggest that 25% of malls in our sample have no anchor competing with non-anchor and vice versa because both %GLA Anchor-NonAnchor and %GLA NonAnchor-Anchor are equal to zero. On the other hand, the 75th percentiles suggest that another 25% of developers allocate 13% of spaces among 9% of the stores) to non-anchors that compete with anchors because %GLA Anchor-NonAnchor (%Store Anchor-NonAnchor) equals 0.13 (0.9) at the 75th percentile. Similarly, 25% of the malls allocate 36% of spaces among 3% of stores to anchors that compete with non-anchors.

Table 3 shows results based on OLS regressions. The dependent variables are two proxies for property value, total appraised value and value per sq. ft. Our test variables are % Anchor GLA in Panel A and % Anchor Store in Panel B. In Model (1), we begin our analysis with test variable only. In Model (2), we control for size. Model (3) and (4) show results adding mall-level and demographic characteristics. Consistent with our model prediction, higher percentages of anchor are associated with lower property values. The effect is nonnegligible. Results in Model (4) of Panel A suggest that a 1% increase in anchor GLA is associated with 1% decrease in property value (=exp(1.038*0.01)=1.01). Compared with total appraised value, the effect on value per square foot is smaller: a 1% increase in anchor GLA is associated with 0.2% decrease in property value per square foot (=exp(0.184*0.01)=1.002). Turning to percentage of anchor measured by number of stores, we find similar results but larger effects. A 1% increase in anchor in terms of number of stores is related to 1.5% decrease in property value. Not all of the coefficient estimates are statistically significant, but they are consistently negative.

All the control variables have the expected signs. The coefficient estimates of Size are positive when the outcome variables are total value but become insignificant when we use value per square foot. Higher number of levels indicate buildings with higher density convey higher value when they are located in urban areas. Malls with higher parking ratio, newer building or malls with a recent renovation are associated with higher value. Consistent with suburbanization, malls located in or near CBD are of less value. Malls located in areas with more density, faster density growth and higher household income have more valuable.

The HHI coefficients presented in Table 4 are critical for understanding the relationship between business concentration and mall performance. In Panel A, HHIs are calculated based on tenant GLA. For example, HHI GLA is the sum of squared shares of GLA of all individual tenants and HHI GLA Top-3 is the sum of squared shares of GLA of three largest tenants. The dependent variables are a set of performance measures, log total appraised value in Models (1) and (2), log appraised value per sq. ft. in Models (3) and (4), vacancy rate in Models (5) and (6), cap rate in Models (7) and (8) and log total rents in Models (9) and (10). Models (1)-(6) include the same set of controls as in Model (4) and (6) of Table 3. Due to a small sample size, we only control for size in Models (7)-(10)[15].

In Panel A, the signs and significance of the HHI coefficients suggest that higher business concentration is associated with lower property value and higher vacancy rate. The magnitude of these coefficient highlights the economic significance of concentration: a one-percentage-increase in HHI GLA is related to 2.1% (=1–exp(-2.105*0.01)) less total property value, 0.3% (=1–exp(-0.348*0.01)) less value per square foot and 0.3% higher vacancy. Although the coefficient estimates of cap rate and rent are statistically insignificant, they are in line with our prediction on the negative relation between business concentration and mall performance. This is consistent with the negative relation between anchor percentage and mall value when half of the mall spaces are occupied by anchors.

In Panel B, we include HHIs based on NAICS GLA. Instead of calculating GLA shares of for each tenant, we calculate shares for each 4-digit NAICS code. We believe these HHIs are better measures of business concentration because they are directly constructed by industry. Higher concentration correlates with worse performance, indicated by lower property value, higher vacancy, higher cap rate and lower rents. All the coefficients are statistically significant. These results provide strong support to our prediction and are consistent with Panel A.

Table 5 presents results on mall performance and competition. Similar to Table 4, the dependent variables are a set of performance measures, log total appraised value in Models (1) and (2), log appraised value per sq. ft. in Models (3) and (4), vacancy rate in Models (5) and (6), cap rate in Models (7) and (8) and log total rents in Models (9) and (10). For each outcome variable, we apply two methods to define competition. Method 1 classify any tenants within the same NAICS code as competitors. Method 2 considers competition between "Department Store" (4-digit NAICS=4521) and other industries with overlapping businesses. Each coefficient represents a separate regression. For example, Column 1 summarizes regression results based on 12 regressions. In Column 1, the dependent variable is total

[15]When we include the same set of controls in Models (7)-(10), the results are still robust and qualitatively similar except that the HHI coefficients become insignificant in few cases.

appraised value and the competition is based on Method 1 (see Appendix 1). The reported coefficients are from 12 different regressions of the outcome variables (in the first row) on 12 different competition measures (in the first column). Control variables are the same as Table 4 and suppressed.

Coefficients of Anchor-Anchor competition suggest a negative relationship between competition among anchors and mall performance. The results are consistent and robust to five different measures of performance and to two different measures of competition (based on GLA and number of stores). On the contrary, coefficients of NonAnchor-NonAnchor competition suggest a positive relationship between competition among non-anchors and mall performance. Perhaps the most interesting results is the comparison between Anchor-NonAnchor and NonAnchor-Anchor. We find that the former one is positively correlated while the latter one is negatively correlated with mall performance, suggesting that having non-anchors (anchors) to compete with anchors (non-anchors) is performance enhancing (destroying). This is consistent with Konishi and Sandfort (2005): on the one hand, collocation of anchor and non-anchor can be mutually beneficial; on the other hand, anchor stores act as a price competitor to non-anchors, lowering their margins. Different from Konishi and Sandfort's model, we relax the assumption that anchors and non-anchors always compete with each other. Our model suggests that collocation of anchor and non-anchor is mutually beneficial even there are many non-anchor stores. This is backed up by our empirical results.

5 Conclusion

This study examines the tenant compositions of anchor stores and nonanchor stores inside shopping malls during the ongoing evolution in the U.S. retail industry. We extend the existing theoretical framework to incorporate a broader definition of anchor stores of different types and to re-examine the trade-off between agglomeration and competition by locating together inside shopping centers. Our model predicts the optimal tenant composition as an equilibrium outcome through the profit maximization strategies made by both tenants and the landlord. We also empirically test our model with a novel dataset of a comprehensive list of tenants inside large-scale shopping centers in the US. Our model and empirical results help explain the entry and exit decisions by retailers, including both anchor stores and non-anchor specialty stores, as well as valuation and investment implications for malls that have difference tenant compositions.

References

1. Anderson, S.P., A. De Palma and J.-F. Thisee, 1992. Discrete Choice Theory of Product Differentiation, MIT Press, Cambridge.

2. Anderson, S.P. and R. Renault, Pricing, Product Diversity, and Search Costs: A Bertrand–Chamberlin–Diar model. 1999. RAND Journal of Economics 30, 719–735.

3. Benjamin, J.D., G.W. Boyle and C.F. Sirmans. 1992. Price Discrimination in Shopping Center Leases, Journal of Urban Economics 32, 299–317.

4. Brueckner, J.K. 1993. Inter-store Externalities and Space Allocation in Shopping Centers, Journal of Real Estate Finance and Economics 7, 5–16.

5. Clapp, J.M., Salavei Bardos, K. and Zhou, T. 2014. Expansions and Contractions of Major US Shopping Centers. Journal of Real Estate Finance and Economics, 48, 16-56.

6. De Palma A., V. Ginsburgh, Y. Papageorgiu and J.-F. Thisse. 1985. The Principle of Minimum Differentiation Holds under Sufficient Heterogeneity, Econometrica 53, 767–782.

7. Diamond, P.A. 1971. A Model of Price Adjustment, Journal of Economic Theory 3, 156–168.

8. Dixit, A. 1979. A Model of Duopoly Suggesting a Theory of Entry Barriers. The Bell Journal of Economics, 10(1), 20-32.

9. Eppli, M, "The Impact of Demographics and Millennials on Commercial Real Estate", Working paper.

10. Eppli, M. and Luis C. Mejia, Inter-Center Retail Externalities, Journal of Real Estate Finance and Economics, 27:3 (2003), 321–333.

11. Fanning, S. 2005. Market Analysis for Real Estate. Chicago: Appraisal Institute.

12. Fischer, J.H. and J.E. Harrington. 1996. Product Variety and Firm Agglomeration, RAND Journal of Economics 27, 281–309.

13. Gehrig, T. 1998. Competing Markets, European Economic Review 42, 277–310

14. Gould, E.G., B.P. Pashigian and C.J. Prendergast. 2005. Contracts, Externalities, and Incentives in Shopping Malls, Review of Economics and Statistics 87, 411-422.

15. Hortaï¿œsu, A. and C. Syverson. 2015. The Ongoing Evolution of US Retail: A Format Tug-of-War. Journal of Economic Perspectives 29, 89-111.

16. Konishi, H. and M.T. Sandfort. 2003. Anchor Stores, Journal of Urban Economics 53, 413-435.

17. Konishi, H. 2005. Concentrating of Competing non-anchor non-anchor retail stores, Journal of Urban Economics 58, 488–512.

18. Liu, C. H., and Liu, P. (2013). Is what is bad for the goose (tenant), bad for the gander (landlord)? A retail real estate perspective, Journal of Real Estate Research, 35(3), 249–282.

19. Pashigian, B.P. and E.G. Gould. 1998. Internalizing Externalities: The Pricing of Space in Shopping Malls, Journal of Law and Economics 61, 115–142.

20. Shanmugam, R. 2013. Anchor-store Quality in Malls: An Economic Analysis, International Journal of Retail & Distribution Management 41, 90-112.

21. Stahl, K. 1982. Differentiate Products, Consumer Search, and Locational Oligopoly, Journal of Industrial Economics 31 (1982) 97–113.

22. Vitorino, M. 2012. Empirical Entry Games with Complementarities: An Application to the Shopping Center Industry. Journal of Marketing Research 49, 175-191.

23. Vives, X., 2001. Oligopoly pricing: old ideas and new tools. MIT press.

24. West, D.S. 1992. An empirical analysis of retail chains and shopping center similarity, Journal of Industrial Economics 40, 201–221.

25. Wolinsky, A. 1983. Retail trade concentration due to consumers' imperfect information, Bell Journal of Economics 14, 275–282.

26. Wolinsky, A. 1986. True monopolistic competition as a result of imperfect information, Quarterly Journal of Economics 101, 493–511.

27. Zhou, T. and J. Clapp. 2015. The Location of New Anchor Stores within Metropolitan Areas, Regional Science and Urban Economics 50, 87-107.

28. Zhou, T. and J. Clapp. 2016. Predicting Risks of Anchor Store Openings and Closings, Journal of Real Estate Finance and Economics 52, 449-479.

Appendix

1. The following figure illustrates the role of each store and how they interact with each other.

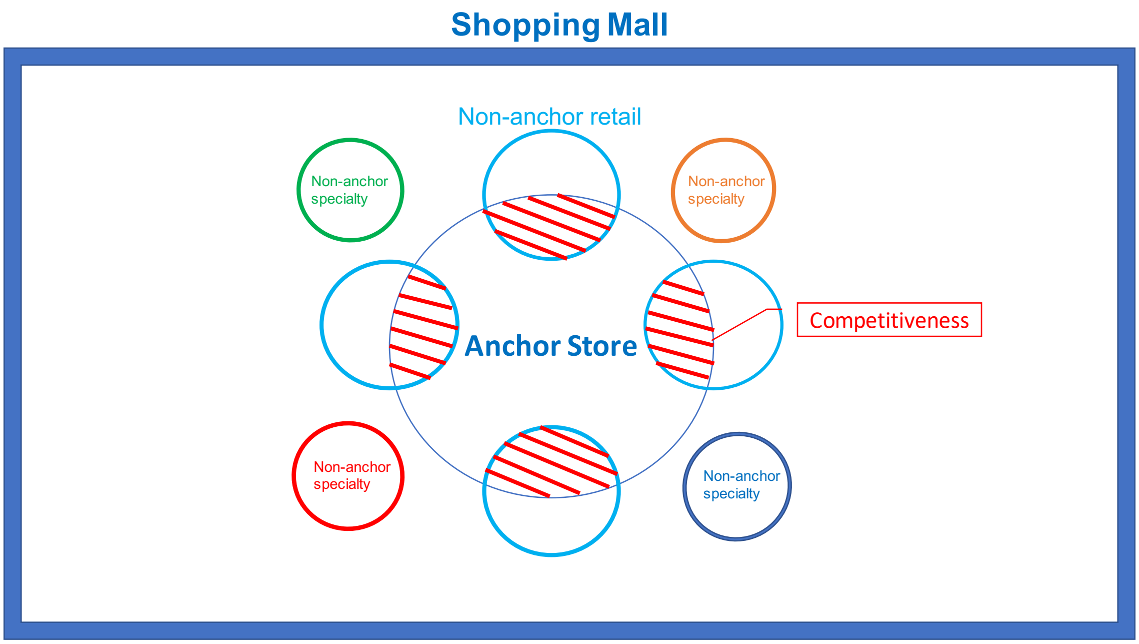


Figure 1: Structure of a shopping mall

2. Derive the demand functions for non-anchor specialty stores

Proof. $A = B + u\cdot v^T$

$A^{-1} = (B + u\cdot v^T)^{-1} = B^{-1} - \frac{B^{-1}u\cdot v^T B^{-1}}{1+v^T B^{-1}u}$ by Sherman-Morrison formula

Let $\theta k_2^\alpha = \epsilon$, and

suppose $A = \begin{bmatrix} 1 & \epsilon & \dots & \epsilon \\ \epsilon & 1 & \epsilon & \vdots \\ \vdots & \epsilon & \ddots & \epsilon \\ \epsilon & \dots & \epsilon & 1 \end{bmatrix} = (1-\epsilon)\mathbf{I}_{N\times N} + \epsilon \begin{bmatrix} 1 \\ \vdots \\ 1 \end{bmatrix}_{N\times 1} \begin{bmatrix} 1 & \cdots & 1 \end{bmatrix}_{1\times N}$

Applying Sherman-Morrison formula:

$B = (1-\epsilon)\mathbf{I}_{N\times N}$, $u = \begin{bmatrix} \epsilon \\ \vdots \\ \epsilon \end{bmatrix}_{N\times 1}$, $v^T = \begin{bmatrix} 1 & \cdots & 1 \end{bmatrix}_{1\times N}$

$A = \begin{bmatrix} 1 & \epsilon & \dots & \epsilon \\ \epsilon & 1 & \epsilon & \vdots \\ \vdots & \epsilon & \ddots & \epsilon \\ \epsilon & \dots & \epsilon & 1 \end{bmatrix} = (1-\epsilon)\mathbf{I}_{N\times N} + \epsilon \begin{bmatrix} 1 \\ \vdots \\ 1 \end{bmatrix}_{N\times 1} \begin{bmatrix} 1 & \cdots & 1 \end{bmatrix}_{1\times N}$

First of all, we derive the term of $B^{-1}u\cdot v^T B^{-1}$:

$$\begin{aligned} B^{-1}u\cdot v^T B^{-1} &= \left(\frac{1}{1-\epsilon}\mathbf{I}_{N\times N}\right)(\epsilon_{N\times 1})(\mathbf{1}_{1\times N})\left(\frac{1}{1-\epsilon}\mathbf{I}_{N\times N}\right) \\ &= \frac{\epsilon}{(1-\epsilon)^2}\mathbf{1}_{N\times N} \end{aligned}$$

Second, we derive the term of $1 + v^T B^{-1}u$:

$$\begin{aligned} 1 + v^T B^{-1}u &= 1 + (\mathbf{1}_{1\times N})\left(\frac{1}{1-\epsilon}\mathbf{I}_{N\times N}\right)(\epsilon_{N\times 1}) \\ &= 1 + \frac{\epsilon}{1-\epsilon}\mathbf{1}_{1\times N}\cdot \mathbf{1}_{N\times 1} \\ &= 1 + \frac{\epsilon N}{1-\epsilon} \end{aligned}$$

Hence, we can derive A^{-1}:

$$
\begin{aligned}
A^{-1} &= B^{-1} - \frac{B^{-1}u \cdot v^T B^{-1}}{1 + v^T B^{-1} u} \\
&= \frac{1}{1-\epsilon}\mathbf{I}_{N\times N} - \frac{\frac{\epsilon}{(1-\epsilon)^2}\mathbf{1}_{N\times N}}{1 + \frac{\epsilon N}{1-\epsilon}} \\
&= \frac{1}{1-\epsilon}\left[\mathbf{I}_{N\times N} - \frac{\epsilon}{1-\epsilon+N\epsilon}\mathbf{1}_{N\times N}\right] \\
&= \frac{1}{1-\epsilon}\begin{bmatrix} 1-\frac{\epsilon}{1-\epsilon+N\epsilon} & -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & 1-\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ \vdots & \vdots & \ddots & \vdots \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} & 1-\frac{\epsilon}{1-\epsilon+N\epsilon} \end{bmatrix}_{N\times N} \\
&= \frac{1}{1-\epsilon}\begin{bmatrix} \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} & -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ \vdots & \vdots & \ddots & \vdots \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} & \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} \end{bmatrix}_{N\times N}
\end{aligned}
$$

Demand functions become

$$
\boldsymbol{q} = A^{-1}(\mathbf{1} - \mathbf{p})
$$

$$
\begin{bmatrix} q_1 \\ \vdots \\ q_N \end{bmatrix} = \frac{1}{1-\epsilon}\begin{bmatrix} \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} & -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} \\ \vdots & \vdots & \ddots & \vdots \\ -\frac{\epsilon}{1-\epsilon+N\epsilon} & \cdots & -\frac{\epsilon}{1-\epsilon+N\epsilon} & \frac{1+(N-2)\epsilon}{1-\epsilon+N\epsilon} \end{bmatrix}_{N\times N} \begin{bmatrix} 1-p_1 \\ \vdots \\ 1-p_N \end{bmatrix}
$$

After simplification, we have

$$
q_i = a - bp_i + d(\sum_{j\neq i}^{N} p_j)
$$

where $a = \frac{1}{1+(N-1)\epsilon}$, $b = \frac{1+(N-2)\epsilon}{(1-\epsilon)(1+(N-1)\epsilon)}$, $d = \frac{\epsilon}{(1-\epsilon)(1+(N-1)\epsilon)}$

3. The profit maximization problem for each non-anchor specialty store

$$
\max_{p_s}(a - bp_s + d\bar{p}_s)(p_s - r_s - c_s) \quad \bar{p}_s = \sum_{i\neq s}^{k_2} p_i
$$

The first order condition for each non-anchor specialty store

$$p_s^* = \frac{a + b(r_s + c_s) + d\bar{p}_s}{2b} \qquad s = 1, ..., k_2$$

As we can see the optimal price should be the best response to the aggregate price of others. Define $(p_1^*, ..., p_{k_2}^*)$ is a Nash equilibrium when the best response functions for each store intersects, that is

$$\bar{p}_s = \sum_{i \neq s}^{k_2} p_i^*$$

Summing over s and dividing by k_2, we find that the average price $\bar{p} = \frac{1}{k_2} \sum_{s=1}^{k_2} p_s^*$ is given by

$$\bar{p} = \frac{1}{2b - d} \left[a + b\left(\frac{1}{k_2} \sum_{s=1}^{k_2} (r_s + c_s)\right) \right]$$

The individual Nash equilibrium prices are p_s^*, where $\bar{p}_s$, the aggregate without non-anchor specialty store s, can be written in terms of the average $\bar{p}$ as

$$\bar{p}_s = k_2 \bar{p} - p_s^*$$

Substituting back in to the first order condition of p_s^*, we obtain

$$p_s^* = \frac{1}{2b + d}(b(r_s + c_s) + a + k_2 d\bar{p})$$

The resulting quantity demands are given by

$$q_s^* = a - bp_s^* + d\bar{p}_s$$

4. An Example of Our Competition Classification

The following figure shows a simplified example of mall composition.

Method 1: compete among same-NAICS code

Store 1's competitor: N.A.

Store 2's competitor: 3, 4

Store 3's competitor: 2, 4

Store 4's competitor: 2, 3

Store 5's competitor: N.A.

Store 6's competitor: N.A.

Store 7's competitor: N.A.

% GLA Anchor-Anchor = 0% (i.e., Anchors 1 and 2 do not compete with each other)

% GLA Anchor-NonAnchor = 20% (i.e., Anchors 1 and 2 as a total facing competition from non-anchor 3 and 4)

% GLA NonAnchor-Anchor = 20% (i.e., Non-anchors 3-7 as a total facing competition from anchor 2)

% GLA NonAnchor-NonAnchor = 20% (i.e., Non-anchors 3-7 as a total facing competition from non-anchor 3 and 4)

% GLA Total = 40% (i.e., counting all the competing stores, 2, 3 and 4)

% GLA Anchor&NonAnchor = 40% (i.e., counting all the competing stores between anchors and non-anchors, regardless who is facing competition)

% Store Anchor-Anchor = 0

% Store Anchor-NonAnchor = 2/7

% Store NonAnchor-Anchor = 1/7

% Store NonAnchor-NonAnchor = 2/7 % Store Total = 3/7

% Store Anchor&NonAnchor = 3/7

Method 2: compete across NAICS codes: department stores compete with clothing & shoe stores; clothing & shoe stores compete with department stores

Store 1's competitor: 2, 3, 4, 5

Store 2's competitor: 1, 3, 4

Store 3's competitor: 1, 2, 4

Store 4's competitor: 1, 2, 3

Store 5's competitor: 1

Store 6's competitor: N.A.

Store 7's competitor: N.A.

% GLA Anchor-Anchor = 50% (i.e., Store 1 and 2)

% GLA Anchor-NonAnchor = 30% (i.e., Store 3, 4 and 5)

% GLA NonAnchor-Anchor = 50% (i.e., Store 1 and 2)

% GLA NonAnchor-NonAnchor = 20% (i.e., Store 3 and 4)

% GLA Total = 80% (i.e., Store 1, 2, 3, 4, 5)

% GLA Anchor&NonAnchor = 80% (i.e., Store 1, 2, 3, 4, 5)

% Store Anchor-Anchor = 2/7

% Store Anchor-NonAnchor = 3/7

% Store NonAnchor-Anchor = 2/7

% Store NonAnchor-NonAnchor = 5/7

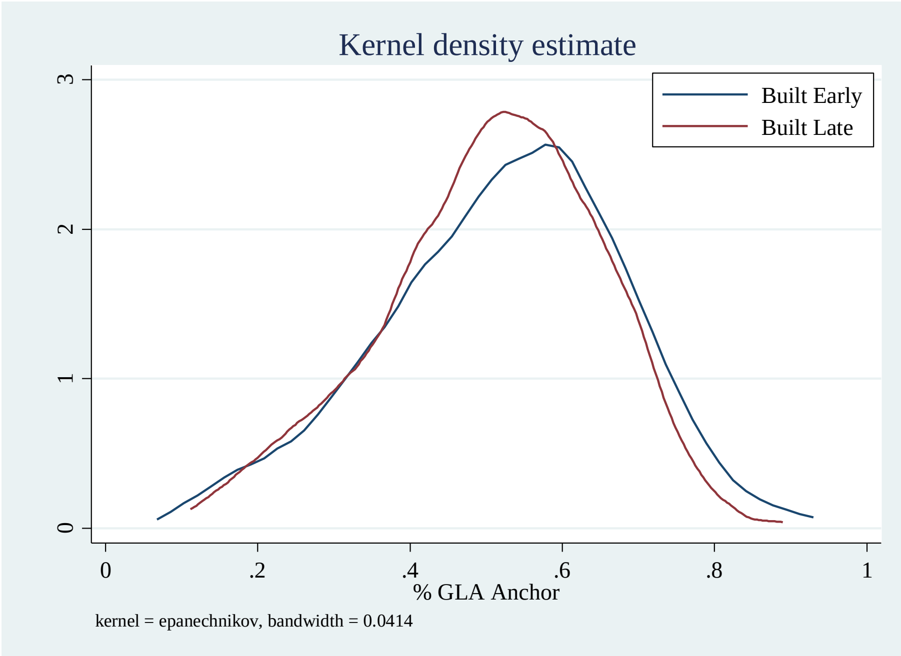
% Store Total = 5/7

% Store Anchor&NonAnchor = 5/7

Figure 1: Distribution of Anchor Pecentage and Year Built

This figure plots the nonparametric estimate of the distribution of anchor percentage for two groups, built early and built late. "Built Early" means year built is in the lowest two quintles (<40 percentile, or year built earlier than 1973). "Built Late" means year built is in the higest two quintles (<60 percentile, or year built later than 1983).

Panel A: Percentage Anchor GLA



Panel B: Percentage Anchor # of Store

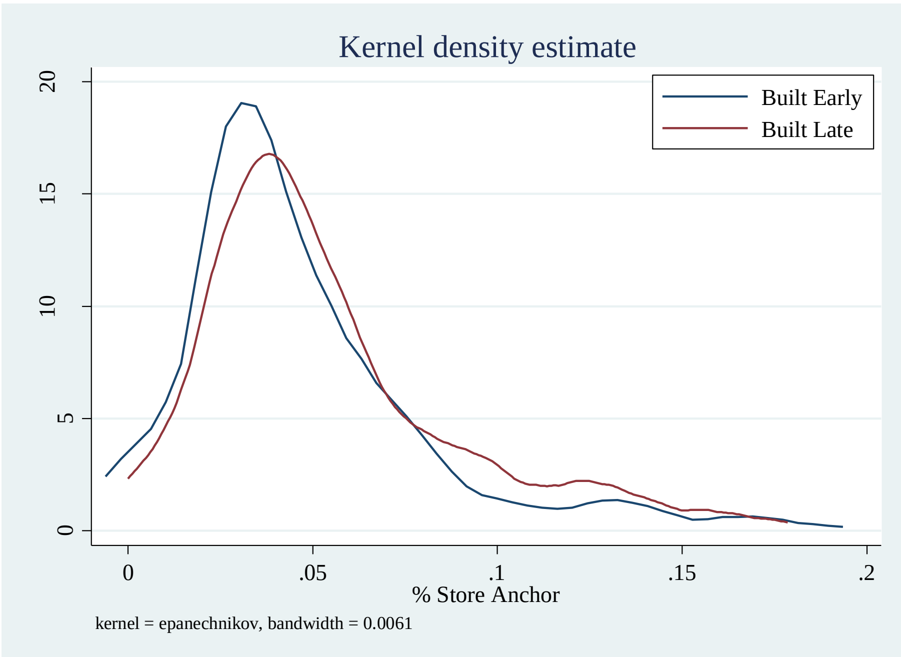


Table 1: Variable Definition

Variable Name	Variable Definition	Source of Data
Proxy for Property Value, Rents, Vacancy		
Log Total Appraised Value	Log of total appraised value	CoStar
Log Appraised Value per SF	Appraised value per sq. ft.	CoStar
Vacancy	Vacancy rate	CoStar
Cap Rate	Capitalization rate	CoStar
Log Total Rent	Log of total triple net rent	CoStar
Mall Characteristics		
Size	Log of total gross leasable area (sq.ft.)	CoStar
Number of levels	Number of levels of the mall	CoStar
Parking ratio	Number of parking spaces per GLA (in 1,000 sq. ft.)	CoStar
Year since built	Number of years since the shopping center was opened	CoStar
Renovation Dummy	Dummy variable that equals 1 if the mall was renovated within the past ten years, 0 otherwise	CoStar
Distance to CBD	Distance to CBD (miles)	CoStar, Census
CBD 5 miles	Dummy variable that equals 1 if the mall is located within 5 miles to CBD, 0 otherwise	CoStar, Census
Composition Inside the Mall		
% Anchor GLA	% GLA of anchor stores	CoStar
% Anchor Stores	% Stores of anchor stores	CoStar
HHI GLA	Herfindahl-Hirschman index (HHI) based on tenant GLA	CoStar
HHI GLA Top-3	Herfindahl-Hirschman index (HHI) based on GLA of top 3 tenants	CoStar
HHI (NAICS GLA)	Herfindahl-Hirschman index (HHI) based on 4-digit-NAICS GLA	CoStar, NAICS
HHI (Top3NAICS GLA)	Herfindahl-Hirschman index (HHI) based on GLA of top-3 4-digit NAICS classifications	CoStar, NAICS
HHI (NAICS #Stores)	Herfindahl-Hirschman index (HHI) based on 4-digit-NAICS number of stores	CoStar, NAICS
HHI (Top3NAICS #Stores)	Herfindahl-Hirschman index (HHI) based on number of stores of top-3 4-digit NAICS classifications	CoStar, NAICS
%GLA Anchor-Anchor	Given anchors, % GLA of competing anchor stores (see Appendix 1)	CoStar, NAICS
%GLA Anchor-NonAnchor	Given anchors, % GLA of competing non-anchor stores (see Appendix 1)	CoStar, NAICS
%GLA NonAnchor-Anchor	Given non-anchors, % GLA of competing anchor stores (see Appendix 1)	CoStar, NAICS
%GLA NonAnchor-NonAnchor	Given non-anchors, % GLA of competing non-anchor stores (see Appendix 1)	CoStar, NAICS
Demographic Characteristics		
Log Household Density	Log of number of households per square miles (measured within 25 miles around the mall)	CoStar, Census
Density Growth	Density growth in the past ten years	CoStar, Census
Log Household Income	Log of median household income (measured within 25 miles around the mall)	CoStar, Census
Household Income Growth	Household income growth in the past ten years	CoStar, Census

Table 2: Summary Statistics

This table shows summary statistics of our dependent variables, *Rents, Vacancy and Proxy for Property Value*, test variables, *Mall Composition* and control variables, including *Mall Characteristics* and *Demographic Characteristics*.

	N	PCTL=5	PCTL=10	PCTL=25	PCTL=50	PCTL=75	PCTL=90	PCTL=95	Mean	STD
Rents, Vacancy and Proxy for Property Value										
Log Total Appraised Value	1178	14.85	15.51	16.77	17.89	18.88	19.77	20.28	17.76	1.67
Log Appraised Value per SF	1175	0.96	1.27	1.53	1.71	1.84	1.97	2.03	1.64	0.37
Vacancy	1184	0.00	0.00	0.00	0.02	0.07	0.18	0.29	0.06	0.12
Cap Rate	217	0.05	0.05	0.06	0.07	0.08	0.11	0.13	0.08	0.03
Log Total Rent	321	14.10	14.57	15.37	16.19	16.83	17.33	17.64	16.00	1.24
Mall Composition										
% Anchor GLA	1204	0.08	0.24	0.40	0.53	0.62	0.70	0.75	0.50	0.19
% Anchor Store	1204	0.01	0.02	0.03	0.04	0.06	0.10	0.14	0.06	0.07
HHI GLA	1204	0.05	0.06	0.08	0.11	0.15	0.22	0.31	0.14	0.11
HHI Top3GLA	1204	0.03	0.04	0.07	0.09	0.14	0.21	0.30	0.12	0.11
HHI (NAICS GLA)	1204	0.13	0.15	0.19	0.26	0.35	0.45	0.52	0.28	0.13
HHI (Top3NAICS GLA)	1204	0.10	0.12	0.17	0.25	0.34	0.44	0.51	0.27	0.14
HHI (NAICS #Stores)	1204	0.08	0.08	0.10	0.13	0.16	0.18	0.20	0.14	0.06
HHI (Top3NAICS #Stores)	1204	0.05	0.06	0.08	0.10	0.14	0.17	0.18	0.11	0.07
Competition based on Method 1										
%GLA Anchor-Anchor	1188	0.00	0.00	0.00	0.36	0.50	0.60	0.65	0.32	0.23
%GLA Anchor-NonAnchor	1188	0.00	0.00	0.00	0.03	0.13	0.23	0.30	0.08	0.11
%GLA NonAnchor-Anchor	1188	0.00	0.00	0.00	0.15	0.36	0.50	0.56	0.20	0.20
%GLA NonAnchor-NonAnchor	1188	0.14	0.20	0.28	0.37	0.47	0.60	0.68	0.38	0.16
%GLA Anchor & NonAnchor	1188	0.00	0.00	0.00	0.23	0.49	0.66	0.72	0.28	0.26
%GLA Total	1188	0.38	0.55	0.76	0.89	0.96	0.99	0.99	0.82	0.20
%Store Anchor-Anchor	1188	0.00	0.00	0.00	0.03	0.04	0.06	0.08	0.03	0.03
%Store Anchor-NonAnchor	1188	0.00	0.00	0.00	0.03	0.09	0.29	0.37	0.08	0.12
%Store NonAnchor-Anchor	1188	0.00	0.00	0.00	0.02	0.03	0.06	0.07	0.02	0.03
%Store NonAnchor-NonAnchor	1188	0.50	0.62	0.78	0.86	0.90	0.93	0.94	0.81	0.14
%Store Anchor & NonAnchor	1188	0.00	0.00	0.00	0.06	0.13	0.32	0.40	0.10	0.13
%Store Total	1188	0.60	0.69	0.84	0.90	0.94	0.96	0.97	0.86	0.12
Competition based on Method 2										
%GLA Anchor-Anchor	1188	0.00	0.00	0.00	0.37	0.50	0.60	0.66	0.33	0.23
%GLA Anchor-NonAnchor	1188	0.00	0.02	0.12	0.20	0.28	0.36	0.42	0.20	0.13
%GLA NonAnchor-Anchor	1188	0.00	0.13	0.31	0.46	0.57	0.65	0.69	0.43	0.19
%GLA NonAnchor-NonAnchor	1188	0.16	0.22	0.30	0.40	0.50	0.62	0.71	0.41	0.17
%GLA Anchor & NonAnchor	1188	0.00	0.25	0.54	0.71	0.80	0.87	0.89	0.63	0.24
%GLA Total	1188	0.55	0.67	0.82	0.91	0.96	0.99	0.99	0.86	0.15
%Store Anchor-Anchor	1188	0.00	0.00	0.00	0.03	0.04	0.06	0.08	0.03	0.03
%Store Anchor-NonAnchor	1188	0.00	0.04	0.27	0.41	0.49	0.56	0.59	0.36	0.18
%Store NonAnchor-Anchor	1188	0.00	0.01	0.02	0.04	0.05	0.07	0.09	0.04	0.03
%Store NonAnchor-NonAnchor	1188	0.53	0.63	0.78	0.86	0.91	0.93	0.94	0.82	0.14
%Store Anchor & NonAnchor	1188	0.00	0.08	0.33	0.45	0.53	0.59	0.63	0.41	0.18
%Store Total	1188	0.64	0.73	0.84	0.91	0.94	0.96	0.97	0.87	0.11

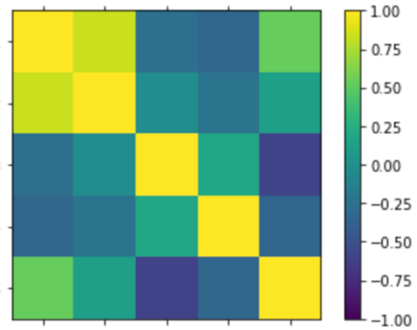
Table 2 (con't)

Mall Characteristics									
Size	1204	12.31	12.59	13.04	13.47	13.81	14.07	14.22	13.36	0.72
# Levels	1204	0.00	0.00	0.00	0.69	0.69	1.39	1.79	0.64	0.65
Parking Ratio	1185	2.66	3.41	4.85	5.99	8.00	12.91	19.22	16.32	221.98
Year Since Built	1204	2.40	2.77	3.33	3.66	3.83	4.01	4.08	3.51	0.57
Renovation Dummy	1204	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.67	0.47
CBD Dummy	1204	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.43	0.49
Distance to CBD	1204	1.15	1.55	2.85	6.62	13.97	22.74	37.03	11.26	15.40
Demographic Characteristics									
Log Household Density	1204	3.24	3.60	4.36	5.41	6.36	6.91	7.46	5.35	1.30
Density Growth	1204	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.01	0.01
Log Household Income	1204	10.57	10.65	10.77	10.90	11.04	11.16	11.27	10.91	0.21
Household Income Growth	1204	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.01	0.00	0.01

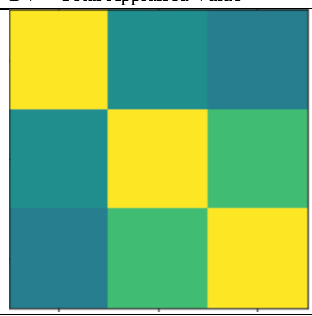
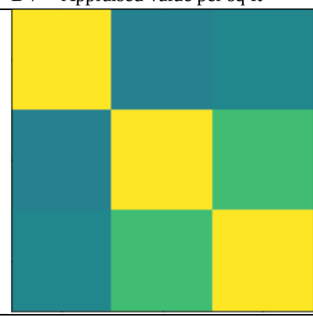
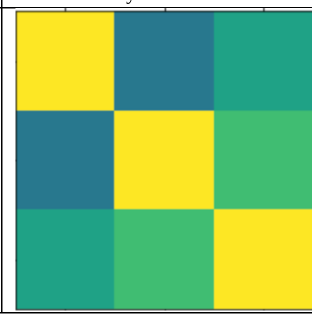
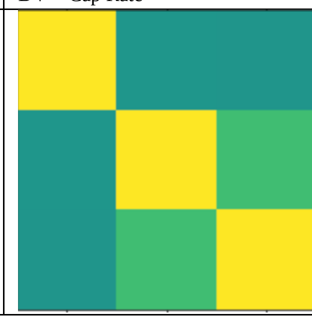
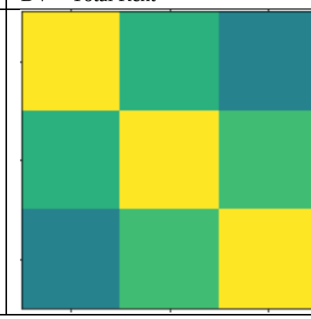
Table 2: Correlation Coefficients

This table summarizes correlation coefficients between mall performance (dependent variables) and test variables.

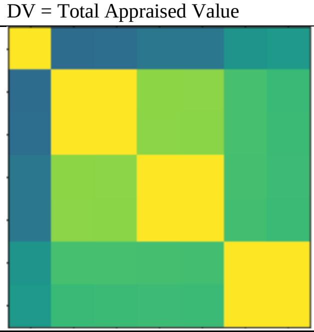
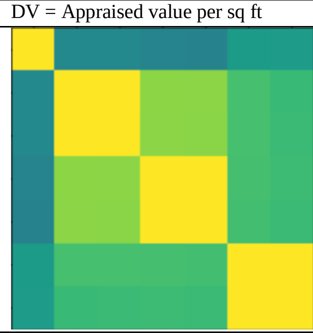
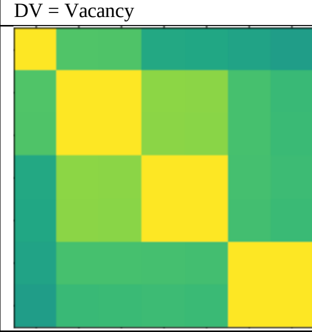
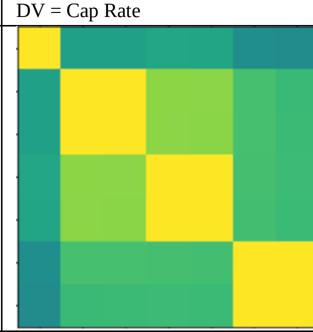
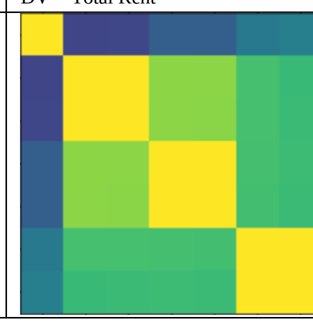
Panel A: Correlation among Measures of Mall Performance

Total Appraised Value	
Appraised value per sq ft	
Vacancy	
Cap Rate	
Total Rent	

Panel B: Correlation between Mall Performance and Anchor Percentage

	DV = Total Appraised Value	DV = Appraised value per sq ft	DV = Vacancy	DV = Cap Rate	DV = Total Rent
DV					
%Anchor GLA					
%Anchor Store					

Panel C: Correlation between Mall Performance and HHI

	DV = Total Appraised Value	DV = Appraised value per sq ft	DV = Vacancy	DV = Cap Rate	DV = Total Rent
DV					
HHI GLA					
HHI GLA Top-3					
HHI NAICS GLA					
HHI NAICS GLA T3					
HHI NAICS Store					
HHI NAICS Store T3					

Panel D: Correlation between Mall Performance and Competition

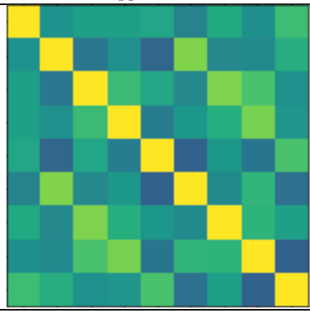
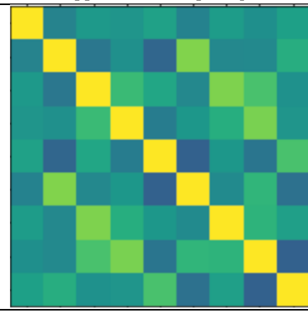
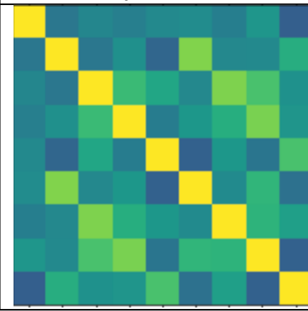
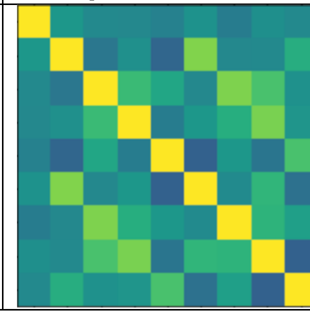
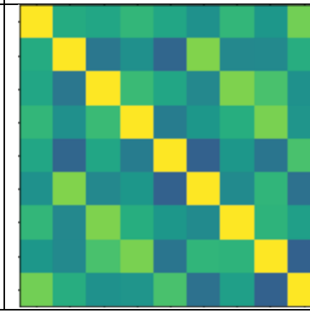
<table>
<tr><th></th><th>DV = Total Appraised Value</th><th>DV = Appraised value per sq ft</th><th>DV = Vacancy</th><th>DV = Cap Rate</th><th>DV = Total Rent</th></tr>
<tr><td>DV</td><td rowspan="9"></td><td rowspan="9"></td><td rowspan="9"></td><td rowspan="9"></td><td rowspan="9"></td></tr>
<tr><td>%GLA A-A</td></tr>
<tr><td>%GLA A-NA</td></tr>
<tr><td>%GLA NA-A</td></tr>
<tr><td>%GLA NA-NA</td></tr>
<tr><td>%Store A-A</td></tr>
<tr><td>%Store A-NA</td></tr>
<tr><td>%Store NA-A</td></tr>
<tr><td>%Store NA-NA</td></tr>
</table>

Table 3: Property Value and Anchor Percentage

A cross-sectional sample consists of a universal list of regional and super regional malls in the US in 2015. Each column represents a separate regression. The reported coefficients are from a regression of proxies for property value on percentage of anchor measured using GLA in Panel A and number of stores in Panel B. *t*-statistics based on Eicker-Huber-White robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel A: Percentage Anchor Measured by GLA

	Log Total Appraised Value				Log Appraised Value per SF			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Anchor GLA	-0.117	-1.560***	-1.133***	-1.038***	-0.242***	-0.292***	-0.207***	-0.184***
	(-0.42)	(-6.22)	(-4.66)	(-4.43)	(-4.18)	(-4.60)	(-3.42)	(-3.11)
Size		1.159***	1.058***	0.958***		0.040**	0.013	-0.006
		(12.65)	(13.63)	(12.74)		(2.17)	(0.77)	(-0.36)
# Levels			0.491***	0.288***			0.092***	0.055***
			(6.75)	(3.98)			(6.43)	(3.50)
Parking Ratio			0.001***	0.001***			0.000***	0.000***
			(6.54)	(6.31)			(4.90)	(4.53)
Year Since Built			-0.058	-0.031			-0.012	-0.000
			(-0.67)	(-0.36)			(-0.68)	(-0.00)
Renovation Dummy			0.221**	0.177**			0.061**	0.053**
			(2.41)	(1.99)			(2.42)	(2.13)
CBD Dummy			-0.326***	0.027			-0.088***	-0.025
			(-2.82)	(0.22)			(-3.22)	(-0.83)
Distance to CBD			-0.026***	-0.010			-0.008***	-0.004
			(-3.03)	(-1.09)			(-3.13)	(-1.64)
Distance to CBD Squared			0.000	0.000			0.000*	0.000
			(1.44)	(0.52)			(1.87)	(1.02)
Log Household Density				0.203***				0.036**
				(3.63)				(2.30)
Density Growth				27.945***				7.323***
				(4.89)				(4.51)
Log Household Income				0.869***				0.175**
				(2.89)				(2.54)
Household Income Growth				1.758				-1.869
				(0.25)				(-1.07)
Constant	17.819***	3.040**	4.303***	-5.461*	1.757***	1.247***	1.615***	-0.380
	(117.41)	(2.52)	(4.03)	(-1.66)	(57.57)	(5.24)	(6.97)	(-0.52)
Observations	1178	1178	1162	1162	1175	1175	1159	1159
Pseudo R^2	0.000	0.220	0.296	0.348	0.015	0.021	0.092	0.139

Panel B: Percentage Anchor Measured by # of Stores

	Log Total Appraised Value				Log Appraised Value per SF			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Anchor Store	-4.013***	-2.310***	-1.539*	-1.476*	-0.407**	-0.391**	-0.245	-0.213
	(-4.53)	(-2.68)	(-1.67)	(-1.83)	(-2.32)	(-2.22)	(-1.30)	(-1.29)
Size		0.994***	0.927***	0.836***		0.010	-0.010	-0.027*
		(11.43)	(12.69)	(11.81)		(0.58)	(-0.68)	(-1.89)
# Levels			0.543***	0.329***			0.102***	0.063***
			(7.49)	(4.58)			(6.96)	(3.94)
Parking Ratio			0.001***	0.000***			0.000***	0.000***
			(5.81)	(5.56)			(4.40)	(4.04)
Year Since Built			-0.099	-0.068			-0.019	-0.006
			(-1.15)	(-0.80)			(-1.09)	(-0.34)
Renovation Dummy			0.240***	0.194**			0.065**	0.056**
			(2.62)	(2.18)			(2.56)	(2.26)
CBD Dummy			-0.345***	0.018			-0.092***	-0.027
			(-2.96)	(0.14)			(-3.33)	(-0.89)
Distance to CBD			-0.027***	-0.010			-0.008***	-0.004*
			(-3.07)	(-1.11)			(-3.15)	(-1.65)
Distance to CBD Squared			0.000	0.000			0.000*	0.000
			(1.51)	(0.58)			(1.91)	(1.06)
Log Household Density				0.212***				0.038**
				(3.79)				(2.40)
Density Growth				28.698***				7.478***
				(5.02)				(4.63)
Log Household Income				0.859***				0.172**
				(2.84)				(2.50)
Household Income Growth				1.115				-1.982
				(0.16)				(-1.13)
Constant	17.986***	4.594***	5.692***	-4.093	1.659***	1.528***	1.860***	-0.146
	(261.49)	(3.89)	(5.41)	(-1.25)	(113.39)	(6.68)	(8.57)	(-0.20)
Observations	1178	1178	1162	1162	1175	1175	1159	1159
Pseudo R^2	0.024	0.201	0.286	0.339	0.005	0.006	0.084	0.133

Table 4: Mall Performance and Business Concentration measured by Herfindahl-Hirschman Index (HHI)

A cross-sectional sample consists of a universal list of regional and super regional malls in the US in 2015. Each column represents a separate regression. The reported coefficients are from a regression of the outcome variables (in the first row) on Herfindahl-Hirschman Index (HHI), measured by tenant GLA in Panel A and by NAICS GLA in Panel B. Columns (1)-(6) controls for the same set of variables as in Table 3 Column (4). Columns (8)-(9) controls for size. *t*-statistics based on Eicker-Huber-White robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel A: HHI based on GLA

	Total Appraised Value		Appraised Value per SF		Vacancy		Cap Rate		Log Total Rent	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HHI GLA	-2.105***		-0.348***		0.265***		0.019		-0.439	
	(-4.46)		(-3.41)		(3.59)		(1.13)		(-1.34)	
HHI GLA Top-3		-1.871***		-0.309***		0.245***		0.017		-0.412
		(-4.25)		(-3.19)		(3.46)		(1.06)		(-1.32)
Size	0.691***	0.705***	-0.051***	-0.049***	-0.073***	-0.074***	-0.010**	-0.010**	1.210***	1.211***
	(8.66)	(8.83)	(-3.27)	(-3.13)	(-7.01)	(-7.07)	(-2.55)	(-2.57)	(18.33)	(18.28)
Constant	-1.399	-1.720	0.307	0.254	1.099***	1.126***	0.204***	0.206***	0.129	0.097
	(-0.42)	(-0.52)	(0.41)	(0.34)	(4.00)	(4.11)	(3.82)	(3.87)	(0.15)	(0.11)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Observations	1162	1162	1159	1159	1168	1168	217	217	321	321
Pseudo R^2	0.348	0.346	0.138	0.137	0.346	0.343	0.048	0.048	0.733	0.733

Panel B: HHI based on NAICS GLA

	Total Appraised Value		Appraised Value per SF		Vacancy		Cap Rate		Log Total Rent	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
HHI GLA	-1.602***		-0.270***		0.094***		0.031**		-0.478*	
	(-5.30)		(-3.93)		(2.59)		(2.04)		(-1.89)	
HHI GLA Top-3		-1.530***		-0.260***		0.088***		0.029**		-0.496**
		(-5.33)		(-3.99)		(2.61)		(2.01)		(-2.06)
Size	0.815***	0.817***	-0.031**	-0.031**	-0.092***	-0.092***	-0.010***	-0.010***	1.220***	1.218***
	(11.19)	(11.23)	(-2.09)	(-2.06)	(-9.80)	(-9.81)	(-2.95)	(-2.99)	(18.37)	(18.25)
Constant	-2.040	-2.093	0.205	0.200	1.345***	1.350***	0.200***	0.202***	0.056	0.086
	(-0.62)	(-0.64)	(0.28)	(0.27)	(5.12)	(5.13)	(4.26)	(4.35)	(0.06)	(0.10)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Observations	1162	1162	1159	1159	1168	1168	217	217	321	321
Pseudo R^2	0.351	0.351	0.140	0.140	0.322	0.321	0.065	0.065	0.734	0.735

Table 5: Mall Performance and Competition

A cross-sectional sample consists of a universal list of regional and super regional malls in the US in 2015. Each coefficient represents a separate regression. For example, Column 1 summarizes regression results based on 12 regressions. In Column 1, the dependent variable is total appraised value and the competition is based on Method 1 (see Appendix 1). The reported coefficients are from 12 different regressions of the outcome variables (in the first row) on 12 different competition measures (in the first column). Control variables are the same as Table 4 and suppressed. *t*-statistics based on Eicker-Huber-White robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Total Appraised Value		Appraised Value per SF		Vacancy		Cap Rate		Total Rent	
	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2	Method 1	Method 2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
% GLA Anchor-Anchor	-0.751***	-0.711***	-0.142***	-0.132***	-0.016	-0.021	0.017*	0.018*	-0.556***	-0.553***
	(-3.79)	(-3.65)	(-3.02)	(-2.87)	(-1.16)	(-1.49)	(1.69)	(1.70)	(-3.85)	(-3.69)
% GLA Anchor-NonAnchor	1.057***	0.805**	0.254***	0.182**	-0.017	-0.070**	-0.009	0.020	0.386	0.457
	(2.78)	(2.16)	(2.87)	(2.10)	(-0.55)	(-2.27)	(-0.65)	(1.38)	(1.19)	(1.46)
% GLA NonAnchor-Anchor	0.103	-0.871***	0.047	-0.149***	-0.009	-0.023	-0.002	0.021*	-0.419**	-0.443**
	(0.49)	(-3.80)	(0.97)	(-2.77)	(-0.65)	(-1.24)	(-0.23)	(1.76)	(2.20)	(-2.04)
% GLA NonAnchor-NonAnchor	1.308***	1.189***	0.225***	0.217***	-0.040	-0.030	-0.018	-0.008	0.577***	0.510**
	(5.21)	(5.01)	(3.71)	(3.71)	(-1.46)	(-1.21)	(-1.60)	(-0.53)	(2.65)	(2.44)
% GLA Total	0.377	0.235	0.076	0.056	-0.068**	-0.076**	0.017*	0.036***	-0.105	-0.009
	(1.44)	(0.73)	(1.25)	(0.77)	(-2.26)	(-2.00)	(1.66)	(2.61)	(-0.57)	(-0.03)
% GLA Anchor&NonAnchor	0.260	-0.390*	0.076**	-0.051	-0.008	-0.041**	-0.003	0.020*	0.303**	-0.251
	(1.62)	(-1.96)	(2.00)	(-1.08)	(-0.70)	(-2.07)	(-0.40)	(1.89)	(2.04)	(-1.20)
% Store Anchor-Anchor	-4.223***	-3.417**	-0.727**	-0.538*	0.126	0.086	0.045	0.037	-2.453***	-2.401***
	(-2.82)	(-2.44)	(-2.14)	(-1.70)	(1.16)	(0.83)	(0.77)	(0.72)	(-3.25)	(-3.20)
% Store Anchor-NonAnchor	1.312***	0.072	0.254***	-0.000	-0.037	-0.073***	-0.030**	0.022*	0.754**	0.764**
	(3.53)	(0.26)	(3.01)	(-0.00)	(-1.62)	(-2.96)	(-2.37)	(1.69)	(2.34)	(2.37)
% Store NonAnchor-Anchor	0.411	-3.363***	0.227	-0.523**	0.280	0.339*	-0.012	0.021	-0.926	-0.968
	(0.31)	(-2.94)	(0.73)	(-2.03)	(1.44)	(1.81)	(-0.30)	(0.71)	(1.49)	(-1.27)
% Store NonAnchor-NonAnchor	1.544***	1.550***	0.298***	0.301***	-0.157***	-0.159***	0.012	0.014	0.353	0.349
	(4.14)	(3.98)	(3.22)	(3.06)	(-3.52)	(-3.47)	(0.91)	(1.03)	(1.61)	(1.57)
% Store Total	1.747***	1.764***	0.366***	0.363***	-0.166***	-0.157**	0.034**	0.038**	0.436	0.443
	(3.57)	(3.30)	(2.98)	(2.78)	(-2.84)	(-2.44)	(2.09)	(2.15)	(1.52)	(1.48)
% Store Anchor&NonAnchor	1.089***	-0.081	0.220***	-0.024	-0.013	-0.055*	-0.021*	0.020	0.626**	0.463*
	(3.15)	(-0.29)	(2.78)	(-0.38)	(-0.42)	(-1.79)	(-1.66)	(1.63)	(2.35)	(1.72)