“If You Build It, Will They Come?” Anchor Store Quality and Competition in Shopping Malls

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Abstract

The ability of shopping centers to attract customers and increase sales depends in part on their anchor stores, the small number of large-sized, high-profile tenants located in every mall. In this paper, I develop a theoretical model of competition between anchor and non-anchor stores in a shopping mall, with the goal of explaining an observed pattern of choices of anchor-store quality levels made by mall developers. In particular, I examine the relationship between a mall's anchor-store quality levels, size, and measures of mall performance (visitor traffic and revenues). I find that mall size, because of its relationship to the probability that consumers will find a “fit” between their preferences and the non-anchor store's goods, has varying effects on price competition between the stores, visitor traffic, mall revenues, and anchor quality levels chosen by mall developers. The primary analytical result is that mall size has a positive and concave, i.e. inverse U-shaped, relationship with the probability that the developer chooses a high-quality anchor over a low-quality one. I then validate the predictions of this model using a data set containing information about key strategic variables for major North American malls, showing that the proposed relationships are robust to the inclusion of inter-mall competitive effects and additional relevant controls.

1 Introduction

Investigating research questions in the shopping center industry has always been of interest to marketers and real estate professionals, especially given the large role shopping centers play in American commerce; the International Council of Shopping Centers estimates that shopping centers account for 14% of non-automobile U.S. retail sales. Strategic analysis of the industry will become even more important as the industry currently faces a cyclical contraction after a period of over-development and in response to a challenging retail climate. According to a recent *Wall Street Journal* article, there exist 84 “dead malls”, centers with sales per square foot below $250, in the United States in early 2009 - up from 40 at the end of 2006. In response to these conditions, mall management companies are now forced to make increasingly strategic decisions regarding redevelopment of struggling properties such as Santa Monica Place in downtown Santa Monica, California, a once-successful enclosed mall which closed in 2008 and is slated to re-open as an open-air center with new tenants in 2010.

Competition between malls and between stores within malls is also of interest to academic researchers in marketing as well as industry professionals, because analysis of shopping center development patterns can provide insight into the nature of how firms, i.e. individual stores within a mall, compete when agglomerated together in close proximity. In addition, shopping centers represent a theoretically interesting variation of the traditional manufacturer-retailer model from vertical control theory, in which the mall developer plays the role traditionally assumed by an upstream manufacturer. Analyzing competitive interactions within this framework can yield insights that generalize beyond shopping malls to any centrally-planned cluster of retail stores, including central business districts in cities and towns.

The goal of this research is to develop a model with testable predictions about mall developers’ decisions regarding one key aspect of a shopping center: the “quality” level of its anchor stores. Malls vary widely in their choices of anchor stores, the small number of large-sized tenants in a mall that, because of their range of offerings and brand recognition, attract shoppers to malls and boost sales of a mall’s tenant base as a whole. Anchor stores are valued by mall developers for their ability to generate positive demand externalities - as modeled by Brueckner (1993), Benjamin et al. (1992) and Gould et al. (2005) - and attract non-anchor mall tenants in turn; the high profile of most anchor stores relative to non-anchors introduces asymmetry between retailers to the traditional multiple-retailer vertical model. One area in which anchor stores differ among themselves is their quality levels; anchors are often categorized into tiers based on the quality of the goods they sell as well as the prestige of their brand names, both of which affect consumers’ willingness to pay for their goods. On these dimensions, there are significant differences between upscale anchors (Bloomingdale’s, Nordstrom), mid-level anchors (Macy’s, Dillard’s), and lower-tier or discount anchors (Target, Sears, J.C. Penney and others). While non-anchor stores also vary in quality level, the smaller number and "marquee" status of a mall's anchors make anchor quality in particular an important strategic variable.

The actual quality levels of anchor stores observed in the mall industry reflect profit-maximizing decisions made by mall developers, who, during the mall planning process, choose whether to attempt to attract high-, mid-, or low-tier anchor stores to their projects. Mall developers' profits, in turn, are often at least partially determined by the profits made by anchor and non-anchor stores in the mall, as well as the cost associated with attempting to attract a higher-quality anchor. Store profits depend on consumers' decisions as to whether to visit the mall, i.e. whether their expected utility from a mall trip, which incurs costs of time and transportation, is positive. Factors that determine how many consumers are attracted to the mall include the quality of the anchor stores, the prices chosen by anchor and non-anchor stores, and the size of the mall, which determines the breadth of merchandise offerings carried within.

Given this setup, the economic question of interest is: What anchor store quality level is optimal for the profit-maximizing mall developer to choose? In particular, when this choice is made conditional on mall size (which is typically determined first in the mall development process as a result of site size limitations and characteristics of a market), how does the developer use the anchor-quality decision to influence competition between mall stores in a way that maximizes its profits?

I model the above competitive framework as a game played by a mall's developer, anchor and non-anchor stores, and consumers, in which the probability that consumers consider purchasing from non-anchor stores, i.e. find a "fit" with the goods available at those stores, is directly related to mall size. In doing so, I find that at a given anchor quality level, there exists a positive and concave relationship, i.e. an "inverse U-shaped" relationship, between mall size and the dependent variables of mall traffic and store profits. I identify two effects that contribute to this concave relationship. At higher mall sizes, the expected value of a mall visit for a representative consumer increases due to the increased fit probability. However, as this probability reaches high values, stores (because they do not know consumers' price expectations) increase their prices by progressively larger amounts, which has a negative effect on consumers' expected utility of purchasing from each store and from the mall visit overall, and drives down mall traffic and store profits.

Regarding the central issue of interest, the developer's decision about which anchor quality level to choose to maximize its own profits, I find that there exists a similarly positive yet concave relationship between mall size and anchor quality, i.e. that the likelihood of the developer choosing high quality over low quality increases and then decreases as mall size increases. Up to a certain point, an increase in mall size causes mall profits to grow faster at higher anchor quality levels than at lower quality levels, as the high anchor quality acts in conjunction with the increased probability of fit to attract more visitors to the mall.

However, when mall size increases beyond a certain point, the stores' resulting price increases as described in the previous paragraph, and their negative effects on mall traffic and combined store profits, are greater at higher anchor quality levels than at lower levels, causing the developer to choose low quality as a means to control the negative demand externalities generated by the stores' pricing decisions.

I then develop an empirical framework to test the predictions of this theory and further investigate the relationship between mall size, anchor quality, mall traffic, and mall profits, using a data set containing information about 1,391 malls across the U.S. and Canada. I correct for potential endogeneity of mall size in relation to anchor quality via the control function method with an instrumental variable. I then show how the developer's anchor-quality decision is influenced not only by mall size but also by the expected anchor-quality choice probabilities of competing malls in each market, using a nested fixed-point algorithm within a maximum likelihood procedure to estimate the equilibrium choice probabilities for each group of competing malls. I also control for mall- and market-level demographic variables (income, age, population density) not included in the theory model and observe how additional significant relationships discovered in this analysis are related to the predicted theoretical results.

The remainder of this paper proceeds as follows. Section 2 describes how previous work provides a foundation for this research problem. Section 3 introduces the data set and presents some preliminary empirical insights. Sections 4 and 5 outline the theoretical model and predictions it yields about the behavior of mall developers, individual mall stores, and consumers. Section 6 presents a more detailed empirical discussion that further analyzes the determinants of developer's anchor quality decision. Section 7 concludes the paper.

2 Background

There exists a considerable body of literature that has studied the economic reasons behind the co-location of firms - as seen in shopping centers and other centralized retail clusters - starting with the basic Hotelling (1929) prediction that a single firm in a cluster of homogeneous retailers cannot gain monopoly power by reducing price (because of factors such as quality and reputation). This principle favors the agglomeration of similar retailers at a single location, a result that has been confirmed even when factors such as consumer uncertainty (Webber 1972) and slight heterogeneity of products and consumer tastes (DePalma et al. 1985, Konishi 2005) are incorporated. Wernerfelt (1994) and Dudey (1990) conclude that firms may find it optimal to co-locate to facilitate search by consumers because it signals to them that competition will keep prices reasonable, thus attracting consumers to the joint location and away from other competitors.

Given the time and travel costs of visiting a mall, the incentive of an increased chance of finding desirable goods as a result of multiple retailers in one space is also necessary for the mall to attract visitors. Datta et al. (2008) isolate the positive effect on the profits of each firm in a cluster resulting from the benefits of agglomeration, as well as the negative effect from competition. Vitorino (2008) is one of the few studies to investigate agglomeration-related issues specifically within the context of the shopping center industry by constructing and empirically verifying a strategic model of entry for mall stores, in which certain stores' entry decisions have "spillover" effects on the profits of other stores. I aim to contribute to this stream of literature by examining how one strategically critical aspect of a mall, the quality of its anchor stores, creates a spillover effect on demand for non-anchor stores' goods and using this to explain the observed empirical relationship between mall size and anchor quality.

Investigating the nature of competition between stores in a mall, because of how this competition can be influenced by the mall developer, is a logical extension of vertical control theory as outlined by Tirole (1988) and Katz (1989). In the theoretical framework proposed in this paper, the mall developer and mall stores are the equivalents of the upstream manufacturer and downstream retailers, respectively, in the traditional model used in much of the vertical control literature. A key variation from the traditional vertical-control paradigm is that the mall developer does not supply retailers with a product to sell to consumers at a markup; instead, developers sell retail space, which can be viewed as a complementary "product" necessary for retailers to operate in the mall.

While this eliminates the traditional negative vertical externality resulting from double marginalization in the traditional manufacturer-retailer model, the lack of integration between the developer and retailers, i.e. the free will of the latter to set prices competitively, results in horizontal externalities as described by Jeuland and Shugan (1983), Matthewson and Winter (1984), and Dixit (1983). Each store's actions represent a balance between the goals of maximizing its own profit per consumer by raising prices, and maximizing all stores' profits by lowering prices and attracting more consumers to the mall; the latter mechanism allows the stores to exert externalities on each other through their pricing decisions. In this setup, the developer's choice variables do not include price (unlike in the typical vertical integration model) but include the type and size of anchor and non-anchor stores chosen to occupy the mall. These choice variables can be thought of as a means to regulate competition and horizontal externalities in a way that maximizes the profits of stores in the mall, which in turn maximize the profits the developer can extract through store rents.

With the exception of studies such as Vitorino (2008) and Konishi and Sandfort (2003), who model the joint profit-maximization problem faced by a mall developer and tenant stores, the majority of research related to the shopping-center industry is dependent on reduced-form empirical methods. While many of these papers, such as those mentioned in the introduction, use these methods to explain rents charged by shopping-center developers to anchor and non-anchor tenants, others address determinants of mall traffic and profit unrelated to tenant mix and intra-mall price competition, such as the influence of competing centers. Smith and Hay (2005) establish that "converting" retail clusters into malls and allowing developers to internalize economic benefits of agglomeration results in intensified competition between developers, while other researchers (Eppli and Shilling 1996, Mejia and Eppli 2003) empirically model the effect of competing malls on a center's sales. Other studies examine how mall sales and traffic are influenced by non-retail mall attractions such as movie theaters (Ooi and Sim 2007). In the empirical analysis section of this paper, I consider these factors and how they relate to my proposed theory of anchor store quality.

3 Data and preliminary empirical analysis

To examine the relationship between anchor quality, non-anchor size, and measures of a mall's success (visitor traffic and profits), I utilize a data set published by the Directory of Major Malls (DMM), consisting of approximately 5,000 malls across all regions of the United States and Canada. Based on their size and tenant mix, these malls are separated into categories, which are listed in Appendix 1.

I restrict the data to malls in the regional, super-regional, value-retail, and lifestyle categories. The categories of regional and super-regional malls are primarily defined by size, including all malls of greater than 500,000 square feet. These malls are well suited to model the proposed competitive framework because malls of this size or larger tend to have multiple stores in categories such as apparel and gifts, implying that the benefits of agglomeration to consumers are more likely to be evident in these malls relative to their smaller counterparts. Lifestyle centers and value retail centers tend to have a retail mix similar to that of regional and super-regional malls, while community centers, power centers, and entertainment centers tend to have a significantly different retail mix and less competition between anchors and non-anchors relative to malls in the categories included in this data set.

To further refine this data set, I checked all malls in these categories for missing or erroneous data and eliminated errant observations, resulting in a data set consisting of a representative cross-sample of 1,391 malls. It is also important to note that while most variables are available for all malls in this subset, data on mall traffic and store sales is only available for 445 and 532 malls in the final data set, respectively; the remaining malls did not provide this data to DMM, as data specifically related to mall performance is often more sensitive and confidential than other mall data.

In addition to variables specific to each mall, the DMM data provides lists of tenants for each mall, including anchor stores, but does not provide any classification of individual anchor stores as it does for entire malls. I divide all department-store mall anchors in this data set into 3 discrete categories as illustrated in Figure 3. To do so, I use a classification scheme in a report by the U.S. Equal Employment Opportunity Commission (2004), which represents the most objective and comprehensive attempt to classify department store anchors in U.S.

malls. The EEOC report first identifies a group of upscale "bridge" and mid-tier "better" brand names in the women's apparel and accessories industry based on an analysis of fashion publications and price points. A statistical cluster analysis of the number of high- and mid-tier designers represented in the stores of the various chains, which yields two significant clusters; the chains are then categorized based on how many of their locations fall into these clusters.

The resulting department-store classification is consistent with how these stores are commonly categorized in retail-industry publications, which not only consider the quality level of the goods offered by these stores across multiple categories but also their perceived value, which is a function of the stores' brand equity. As most malls used in the data analysis for this paper have multiple anchors, I define the overall mall anchor quality level for each mall as being equivalent to the quality level of its highest-quality anchor, as it is this anchor-quality "ceiling" (i.e. whether at least one anchor of a higher quality level is available within the mall) that has the greatest implications for consumers' overall "valuation" of a visit to the mall.

Also, even though non-department store anchors are common in shopping malls (albeit to a limited extent in this data set because of their relative prevalence in the omitted mall categories), I categorize them as low-quality anchors. The majority of non-department-store anchors in this data set are restaurants or entertainment destinations, not retailers, and do not compete with non-anchor stores across the same merchandise categories. Furthermore, in instances where a non-department-store anchor exists that offers the equivalent of "high quality" as well as merchandise that overlaps with the mall's non-anchors, such a store is virtually always accompanied by at least one high-quality department-store anchor, which already ensures that the mall's overall anchor-quality rating will be "high" as defined earlier.

Quality level	Description	Stores included in classification
q_H	Upscale department store	Barney's, Bloomingdale's, Holt Renfrew, Neiman Marcus, Nordstrom, Saks Fifth Avenue
q_M	Mid-tier department store	Carson Pirie Scott, Dillard's, Lord & Taylor, Hudson Bay, Macy's[1], Parisian, Von Maur
q_L	Discount department store or non-department store anchor	All other department stores (including Target, Sears, J.C. Penney) and non-department store anchors

Figure 1: Classification of anchors in data set into 3 distinct quality levels: high, medium, and low.

Using the above categorization scheme, preliminary analysis of the data shows that across the entire data set, malls with an anchor-quality rating of medium comprise roughly half of all malls, with low-anchor-quality malls the next most popular category and high-anchor-quality malls a distant third. To further examine the distribution of anchor quality, I divide the data set into quartiles based on the general leasable area (GLA) of each mall's non-anchor stores, which is closely correlated ($\rho = 0.8055$) to overall mall GLA or "mall size", a variable identified in the introduction as being of interest; the significance of non-anchor GLA in particular will be discussed later. The breakdown of anchor quality by GLA quartile is shown in Figure 2, in which higher-quality malls become more prevalent when "mall size" as represented by this variable increases.

Quality level	Total	Q1	Q2	Q3	Q4
q_H	192 (13.8%)	17 (4.9%)	24 (6.8%)	53 (15.2%)	98 (28.7%)
q_M	673 (48.3%)	111 (31.8%)	211 (60.1%)	204 (58.5%)	147 (43.0%)
q_L	526 (37.8%)	221 (63.3%)	116 (33.0%)	92 (26.4%)	97 (28.4%)

Figure 2: Distribution of malls by anchor quality rating (equivalent to anchor quality rating of mall's highest anchor).

However, it is worth pointing out that the relative percentage of low-anchor-quality malls slightly increases when moving from quartile 3 to quartile 4, and that the relative rate at which medium quality is chosen over low quality decreases. This is even more noteworthy in light of the fact that larger malls tend to have more anchors, which should increase the likelihood that at least one anchor will be high- or medium-quality and that the mall's anchor quality rating as defined here will be high or medium. Based on this table, it is worth considering not only whether a theoretical explanation exists for the likelihood of choosing a high- and/or medium-quality anchor level over a low-quality anchor level increasing with non-anchor GLA (which Figure 2 seems to suggest) but also whether that same likelihood decreases with anchor size for high non-anchor GLA levels (which is not strongly evident in Figure 2 but may be in evidence when the appropriate controls are included in the empirical analysis). The model described in the following section addresses these questions.

4 Theoretical framework: Overview

In this section, I analyze the relationship between mall size and anchor quality by presenting a model of a mall which consists of two stores, an anchor store and a non-anchor store.

Both stores in this model are assumed to sell a single type of item. Valuation of each store's version of this good varies among consumers; consumers' relative preference for the anchor and non-anchor version is represented by a variable v with a uniform unit distribution. The inclusion of this variable allows the model to represent a type of consumer heterogeneity which motivates the agglomeration of anchor and non-anchor stores in malls, as including both store types allows the mall to better appropriate consumer surplus.

Consumers' purchase decisions are also influenced by whether the good offered at either the anchor or non-anchor store "fits" with their product preferences, which occurs with probability α or β, respectively. Only if there is a fit does the consumer consider buying from that store. As anchor stores are usually more widely-known and consumers tend to have more information about their goods prior to visiting the store, the anchor fit probability is normalized to $\alpha = 1$. However, the analysis in this paper generalizes to any case where $\alpha > \beta$. The fit parameter β is linked to the breadth of offerings of the non-anchor store, which for malls in the data set can be associated with the size of the non-anchor component of the mall's retail space. As mentioned in the introduction, this size is usually determined before the developer chooses anchor quality; therefore, the associated fit parameter β is treated as exogenous.

Given this specification, the game played by the developer, the stores, and consumers proceeds involves the following stages, which are based on those in the model proposed by Konishi and Sandfort (2003):

- **Stage 1**: The developer chooses q.
- **Stage 2**: The anchor and non-anchor stores endogeneously and simultaneously set prices p_A and p_N.
- **Stage 3**: Consumers decide whether to visit the mall, based on their expected utility upon visiting the mall. This decision is made based on fit probability, expected valuation and prices.
- **Stage 4**: Consumers decide whether to purchase from the anchor store or non-anchor store based on fit, actual valuation and prices.

Stores' ability to set prices independently in stage 2 is a central feature of this model. While many mall stores are part of chains and are somewhat constrained by corporate-level decisions, they still have leeway in terms of price promotions, "clearance" discounts and the choices of specific brands and items to stock at each location.

At the conclusion of stage 4, the developer acts as the "residual claimant" on all profit earned by the anchor and non-anchor stores. In actuality, the store profits claimed by the developer represent all profits beyond a pre-determined reservation profit level for each store; the developer extracts all surplus economic rent from each store. This setup reflects the fact that many contracts between mall developers and tenants are at least partially based on sales. As a result, the developer's choice of q in stage 1 is intended to induce the anchor and non-anchor stores and consumers to act in such a way that combined store profits are maximized. In the remainder of this section, I further examine the behavior of the various players at each stage of the game, using backwards induction to compute the subgame-perfect Nash equilibria at each stage.

4.1 Developer- and store-level model details

In the typical shopping center development process, the act of securing lease commitments from anchor tenants is a complex procedure. This step often takes place in conjunction with determining the feasibility of a center and securing funding for its construction, due in large part to anchor tenants' importance to the success of the center. However, it is usually the case that the mall developer must have a good sense of many of a center's details - including its estimated size - before making a sales pitch to prospective anchor tenants. For the purposes of this model, the developer's choice of a discrete anchor quality level $q \in \{q_L, q_H\}$, implicit in its choice of which quality level of retail store fills the single anchor store space in the mall, is a necessary yet reasonable simplification of this process.

In this model, the developer's profits depend on the maximum rents he can extract from the anchor and non-anchor stores as a residual claimant. For each store, this is equal to the store's total profits, which will be defined in the following section. As mentioned in the introduction, the developer also incurs a cost based on the chosen level of anchor quality q. This cost represents the resources a developer must expend to attract a relatively high-quality anchor to the mall, primarily consisting of increased spending on common areas within the mall but outside the individual stores.

The developer's profit function is represented by the following specification in which c is a cost parameter:

$$\Pi_D = \Pi_A + \Pi_N - c(q - q_L)$$

The developer's goal in stage 1 is to choose the value of $q \in \{q_{L,} q_H\}$ that maximizes this profit function, given his anticipation of store and consumer behavior in subsequent stages.

Conditional on the anchor quality parameter q, the anchor and non-anchor stores set their prices simultaneously in stage 2 to maximize their individual profits[2], which are specified as follows:

$$\Pi_A = p_A P(A)\overline{M}$$
$$\Pi_N = p_N P(N)\overline{M}$$

These profits are a function of:

- p_A and p_N: prices chosen by each store
- $P(A)$ and $P(N)$: probability that a representative consumer chooses to buy from either store
- $\overline{M}$: expected number of consumers who visit the mall.

Closed-form expressions for $P(A)$, $P(N)$, and M and the equilibrium prices are derived in Appendix 2 and 4.

[2]Although stores have cost functions as well, this model only considers stores' revenues, given that cost function data is unavailable.

4.2 Consumer-level model details

Once the anchor quality level is chosen and prices are set in stages 1 and 2, consumers then decide whether to visit the mall, which is conditional on their expected decision about which store to purchase from once they visit the mall. I describe the latter decision first and then examine the consumer's mall-visit decision.

Consumer valuation for the good offered by either store (defined as V_A and V_N) is a function of two components: an unconditional "base" valuation, and the consumer's realized value of the preference variable v. The base valuation represents the value that a consumer who has the strongest possible preference for one store would have for that store's good. For the anchor store good, this base valuation is equal to the anchor quality choice variable q; for the non-anchor store, base valuation is normalized to 1. In this setup, the fit probability β can be thought of as a "horizontal" variable affecting whether a consumer's preferences match with a store's offerings, whereas the anchor quality variable q can be thought of as a "vertical" variable affecting consumer's actual valuation of one of the stores' goods conditional on such a match.

Consumer valuation is also dependent on the consumer's value of v, involving a travel cost similar to that from the traditional Hotelling model, based on the following:

- Distance between the consumer's position on the 0-1 range of v and the value of v that represents maximum preference for that store (at which valuation is equal to the base valuation)
- A parameter t which represents the level of differentiation between the anchor and non-anchor stores, i.e. the "travel cost" deducted from maximum possible valuation as a result of being at a value of v other than 0 or 1.

For the anchor and non-anchor stores, the maximum preference occurs at $v = 0$ and $v = 1$, respectively, at which $V_A = q$ and $V_N = 1$. Valuation decreases from these levels as v or $(1 - v)$ increases, as shown graphically in Figure 3 for the cases in which consumers consider both stores and the anchor store only.

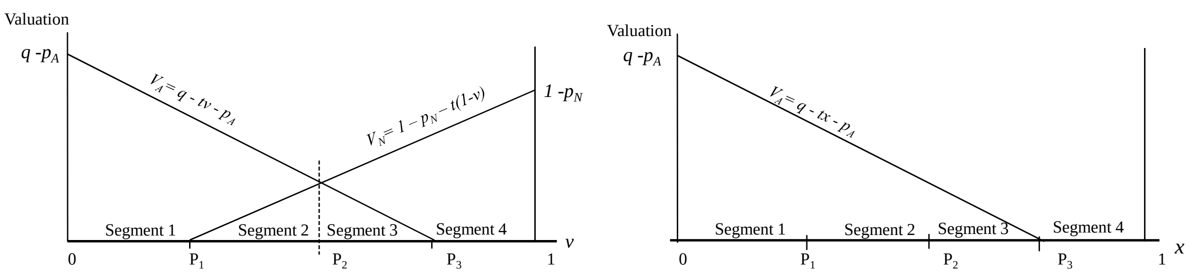

Figure 3: Valuation of both stores as a function of v, q, and firms' prices, for 2 cases: (1) Consumer considers both stores, (2) Consumer considers only anchor store.

Once the consumer visits the mall, she finds out whether she finds a fit with the non-anchor store's good, which is determined by the fit probability parameter β. The consumer's purchase decision then depends on the consumer's valuation of the goods of whichever store(s) are in her consideration set at that point. These valuations are a function of the consumer's relative-preference variable v, the mall's anchor quality variable q, and the endogenously determined prices p_A and p_N. If consumers consider both stores, they purchase from the store for which valuation net of price is greater.

These rules can be used to estimate how many consumers choose to visit the mall. Although it is not known until a consumer visits the mall whether a fit with the non-anchor store is found or not, the value of β is known *a priori* by consumers. V_A and V_N are also known in advance, as they are a function of the mall anchor's value of q as well as the consumer's own relative preference v. Consumers decide whether to travel the mall based on their expected utility of such a trip, which is a function of the probability of purchasing from one store or the other conditional on visiting the mall (i.e. in stage 4) as well as the expected utility from doing so.

$$EU = P(N)E(U \mid N) + P(A)E(U \mid A)$$

These purchase probabilities for a given consumer depend on that consumer's value of v as well as whether that consumer's consideration set includes both the anchor and non-anchor store or just the anchor store. As shown in Figure 3, the entire consumer base can be divided into four distinct segments based on their individual values of v.

Figure 4 depicts the anticipated purchase decisions made by consumers for each possible consideration set as a function of v. Closed-form expressions for the boundary points P_1, P_2, and P_3 are derived in Appendix 3.

	v interval	Fit with A+N	Fit with A only
		P = β	P = $(1-\beta)$
1, 2	$v \in [0, P_2]$	A	A
3	$v \in [P_2, P_3]$	N	A
4	$v \in [P_3, 1]$	N	none

Figure 4: Anticipated purchase decisions for consumers for various combinations of consideration set and preference level v.

These anticipated purchase decisions conditional on fit, as well as the probability of each "fit" scenario (as shown in the second row of the table), lead directly to an expression for the unconditional purchase probabilities $P(A)$ and $P(N)$ associated with each v interval, as shown in Figure 5.

These unconditional purchase probabilities can be used to calculate expected utility for a representative consumer in each of the four intervals of v shown in the table. Assuming consumers' reservation utility (which reflects a combination of transportation cost and utility

	v interval	$P(A)$	$P(N)$
1, 2	$v \in [0, P_2]$	1	0
3	$v \in [P_2, P_3]$	$1-\beta$	β
4	$v \in [P_3, 1]$	0	β

Figure 5: Unconditional purchase probabilities for consumers for various intervals of v, equal to 0 for certain intervals.

from shopping at the nearest competing mall or retail area) has a uniform unit distribution, these expected utilities are equal to the probabilities that a given consumer in each segment will visit the mall; the consumer will do so if his expected utility of a mall visit is greater than his reservation utility. Calculations of expected utility by segment as well as expected mall traffic are shown in Appendix 4.

5 Theoretical framework: Predictions

Having outlined the model in stages, I next present testable propositions of how prices, mall traffic, store profits, and developer's choices of anchor-quality level depend on the exogenous value of non-anchor size, which affects consumer behavior via the non-anchor "fit" probability β. I do so by examining the equilibrium behavior of the players at each stage of this model, culminating in the primary result in stage 1, in which the developer chooses a profit-maximizing level of mall anchor quality q given the exogenous value of β.

5.1 Store-level predictions: Price equilibrium

I first examine stores' pricing decisions with respect to the developer's choice variable q (referred to as a "parameter" for this part of the analysis) and the exogenous fit parameter β. It is important to observe that higher levels of q "favor" the competitive position of the anchor store, as this results in higher consumer valuation of that good for all values of v, and greater consumer surplus for the anchor good. Likewise, higher levels of β favor the non-anchor store, as this increases the probability that consumers will find a fit with that store's good and consider that store.

It is also necessary to consider the economic intuition behind two effects that balance each other equally at each firm's price equilibrium: a "price effect", equivalent to the additional profit the firm would gain from the share of consumers (segments 1, 2, and 4 in Figure 3) who continue to buy from a store if it raised its price from the equilibrium value, and a "probability change effect", equivalent to the profit lost from the share of consumers (segment 3) who no longer buy from that store as a result of the higher price.

A higher value of q results in a new equilibrium in which the anchor store charges a higher price while the non-anchor store charges a lower price. Considering the anchor store first, an intuitive explanation for this result is that higher anchor quality results in higher consumer valuation and demand for the anchor store's good for all consumers regardless of their relative preference v; the anchor store can increase its price while still preserving higher demand and ending up with higher profit than at the previous equilibrium. As a direct result of this, the share of consumers who buy from the non-anchor store (as calculated in Appendix 2) decreases. The non-anchor store therefore has more to gain from reducing price rather than increasing it - the profit lost via the "price change" effect comes from a smaller consumer base.

At higher levels of non-anchor fit probability β, both stores charge higher prices. The non-anchor store, which is "favored" by the increase in this parameter, is able to increase price at higher values of this parameter and still earn higher profits. However, in contrast to the non-anchor store in the previous case, the anchor store has more to gain from increasing price along with the non-anchor store, choosing a strategy of making more profit from a consumer share that increases as a result of the non-anchor's price increase. This reveals that stores, who do not know consumers' price expectations, respond to an increase in mall size with a mutual strategy of increasing prices to maximize the expected profit per consumer who visits the mall.

5.2 Store-level predictions: Mall traffic and store profits

The preceding discussion of how an increase in β results in reduced price competition is necessary to set up the model's first prediction, about the effect these same parameters (as well as their resulting effects on prices) have on the market size, i.e. the number of expected mall visitors.

Proposition 1. Increases in the parameters of the model affect equilibrium mall traffic (number of consumers who decide to visit the mall) as follows:

- *Increased anchor quality (q) results in greater mall traffic.*
- *Increased non-anchor fit probability (β) results in greater mall traffic for sufficiently low initial values of β, i.e. the relationship is positive and concave (inverse U-shaped).*

To consider the comparative statics with respect to mall traffic in this model, it is necessary to decompose the effect of a parameter increase on mall traffic into two sub-effects: a "direct" effect, corresponding to the effect of the parameter increase on mall traffic independent of price (i.e. with price remaining fixed), and a "price" effect, corresponding to the effect of the parameter increase on mall traffic via its effect on either of the stores' prices. These sub-effects correspond to the first term and the remaining terms, respectively, in the decomposition below:

$$\frac{dM}{dq} = \frac{\partial M}{\partial q} + \frac{\partial M}{\partial p_A}\frac{\partial p_A}{\partial q} + \frac{\partial M}{\partial p_N}\frac{\partial p_N}{\partial q}$$

The direct effect, price effects, and overall effect on mall traffic for changes in each parameter are summarized in Figure 6. Considering first the comparative statics for anchor quality q, the direct effect of a higher anchor quality level on mall traffic is positive: ignoring the effect it has on prices, a higher-quality anchor store increases valuation of the anchor store good and makes expected utility higher for at least some consumers. The second, third, and fourth columns depict effects of the changes in p_A and p_N outlined in the previous section as well as the combined effect. An increase in q leads to an overall positive effect on mall traffic because the positive direct effect is stronger than the negative price effect, i.e. the increase in quality drives additional consumers to the mall despite the negative effect of the resulting changes in stores' prices.

	Direct	p_A	p_N	$p_A + p_N$	*Overall*
$\frac{dM}{dq}$	+	-	+	-	+
$\frac{dM}{d\beta}$	+	-	-	-	+/-

Figure 6: Signs of direct, price, and overall effects on mall traffic in response to changes in q and β.

A similar explanation holds as non-anchor fit probability β increases at relatively low values, but the effect on mall traffic of an increase in β eventually becomes negative. As β approaches sufficiently high levels, the price increases chosen by both firms grow increasingly large, resulting in a negative price effect that gradually overtakes the positive direct effect in magnitude; the economic implication is that increases in non-anchor fit probability, beyond a certain point, cause firms to overreact in their price increases, which creates a negative effect on mall's ability to draw visitors. I next examine how changes in parameters translate to changes in store-level profits.

Proposition 2. Increases in the parameters of the model affect store-level profits as follows:

- *Increased anchor quality (q) results in greater profits for each store.*
- *Increased non-anchor fit probability (β) results in greater non-anchor store profit, but results in greater anchor store profit only for sufficiently low initial levels of β.*

It is somewhat surprising that an increase in q not only benefits the anchor but also the non-anchor, mainly because of the increased mall traffic and in spite of a lower probability that consumers purchase from the non-anchor and a lower non-anchor price. Not only does the increase in mall traffic appear to be the key driver of increases in both stores' profits when q increases, but the non-anchor store's price cut contributes to the increase in mall traffic, generating a demand externality that benefits the anchor as well.

The result of greatest interest pertains to increases in non-anchor fit β; while this results in an increase in the favored non-anchor store's profits as expected, anchor store profit varies in the same way that mall traffic varies as described in Proposition 1, first increasing and then decreasing as β increases. Recall that store profit, as defined in Section 4.1, is a function of three things: probability of purchase from a store, the store's price, and mall traffic. The increase in non-anchor fit probability is accompanied by a higher price charged by the anchor store, which have negative and positive effects on the anchor store's profit, respectively, but the overall effect on anchor profit is primarily driven by the effect on mall traffic described in Proposition 1.

In addition, the combined profits of the anchor and non-anchor store also have a similarly concave relationship with non-anchor fit β. While the non-anchor store's profit always increases with β, the decrease in the anchor store's profit eventually offsets this increase and results in lower combined profit. This finding sets up the key prediction of the theoretical model, relating to the developer's choice of q.

5.3 Developer-level predictions

To examine the behavior of the model at the developer's level, I first define q_H and q_L as a function of β and t in such a way that all four segments in Figure 3 exist (i.e. such that the two stores are guaranteed to "cover" the market completely)[3]. To define the relative attractiveness to the mall developer of q_H and q_L, the gap between developer's profits at the two levels of q, $\Pi_D(q_H) - \Pi_D(q_L)$ is considered. It is by examining the derivative of this gap with respect to non-anchor fit probability that one can answer the following question: What impact does this parameter have on whether the developer chooses high or low anchor quality q?

Proposition 3. Increased non-anchor fit probability (β) increases the relative attractiveness to the developer of the high anchor quality level only for sufficiently low initial values of β.

In this result, the "horizontal" non-anchor fit probability has an effect on the "vertical" choice variable, the developer's profit-optimizing choice of anchor quality. Proposition 2 predicted an increase in combined store profits, which are equivalent to developer profits, [4] as a result of higher consumer valuation, mall traffic, and store profits as non-anchor fit probability increases from 0 to a certain point; by examining how the gap between developer profits at high and low quality levels changes, I observe that this effect is amplified at higher anchor quality levels, causing the developer to favor higher anchor quality. This is a result of increasing non-anchor fit and higher anchor quality acting in conjunction to attract enough new consumers to the mall to outweigh the effect of both stores' price increases.

Similarly, what was observed as the non-anchor fit probability increases beyond a certain point - a negative effect on mall traffic and profits as a result of the stores' increasingly large price increases - is also amplified at higher anchor quality levels, causing the developer

[3]The results generalize to all constraint-compliant definitions of q_H and q_L.

[4]While Proposition 2 was actually concerned with the effect on combined store profits, this is treated as equivalent to developer profits in the discussion of Proposition 3 as the developer's cost term does not affect this analysis.

to favor lower anchor quality. The implication is that as mall size grows large enough, the developer is forced to zuse his control over anchor quality (in particular, by choosing lower anchor quality) to manage the negative externalities generated by the stores' price increases.

The preceding results discuss how the developer's likelihood of choosing high or low anchor quality is affected; as to the actual choice itself, it is possible for certain values of the cost parameter c for observed anchor quality levels to change from low quality to high and back to low as the non-anchor fit parameter β increases from 0 to 1. In other words, this suggests that high-quality anchors would be found in mid-sized malls. This prediction raises a question for the empirical analysis of the predictions of this model: Is this pattern actually observed in the data when the appropriate controls are added? Even in the absence of data on store prices and mall contracts, market structure alone (i.e. observed mall sizes and quality levels) can be used to test the predictions of Propositions 1, 2, and 3: this analysis is the subject of the following section.

6 Empirical model

In this section, I develop an empirical model to verify the proposed relationships between the mall developer's anchor-quality decision and the other variables mentioned in the previous section: mall size, mall traffic, and store profits. Using the data setup described in section 3, I begin by testing the intermediate predictions in Propositions 1 and 2, then use a simple multinomial logit choice model and a more advanced variation incorporating between-mall competitive effects to present evidence for the main result in Proposition 3.

6.1 Determinants of mall traffic and sales profit

I first construct a basic ordinary least-squares (OLS) regression to test the relationships between the dependent variables of mall traffic and non-anchor store sales[5], and the independent variables of anchor quality and non-anchor size, as proposed in Propositions 1 and 2.

The OLS model is specified as follows:

$$Y_i = \alpha_i + \beta_1 GLA_{Ni} + \beta_2 GLA_{Ni}^2 + \beta_3 q_{Hi} + \beta_4 q_{Mi} + \beta X_i + \varepsilon_i$$

in which:

Y_i = Dependent variable for mall i, defined as either (1) mall traffic, i.e. number of annual mall visitors, or (2) non-anchor store sales per square foot

GLA_{Ni} = Total non-anchor GLA

q_{Hi} = Binary variable equal to 1 if the mall's highest-quality anchor has a quality rating of q_H, 0 otherwise

[5]Sales figures for anchor stores are unavailable in this data set.

q_{Mi} = Binary variable equal to 1 if the mall's highest-quality anchor has a quality rating of q_M, 0 otherwise

X_i = Vector of additional mall-specific regressors (described in Appendix 5)

ε_i = Mall-specific unobservables (error term)

The results for the first regression in which mall traffic is the dependent variable, as shown in Figure 7, display evidence for a positive relationship between higher-than-minimum levels of mall anchor quality and number of mall visitors. I also find that there exists a positive yet concave relationship between non-anchor size and visitor traffic; the coefficient for the non-anchor size term is positive and significant, and the coefficient for the quadratic term is negative and significant.

Variable	**Coefficient (std. error)**	**T statistic (significance)**
Intercept	3.43 x 10^6(3.27 x 10^6)	1.05 (0.295)
NA (non-anchor) size effect	**14.26 (4.12)**	**3.46 (0.001)**
NA size^2 effect	**-4.93 x 10^{-6} (2.89 x 10^{-6})**	**-1.71 (0.088)**
Effect of "anchor quality = H"	**2.05 x 10^6 (9.11 x 10^5)**	**2.25 (0.025)**
Effect of "anchor quality = M"	**1.85 x 10^6 (6.44 x 10^5)**	**2.87 (0.004)**
Population (10 mile radius)	**0.858 (0.383)**	**2.24 (0.026)**
Income (10 mile radius)	13.10 (13.10)	1.00 (0.318)
Age (10 mile radius)	**-1.49 x 10^5 (7.40 x 10^4)**	**-2.01 (0.045)**
Herfindahl index	1.30 x 10^7 (8.17 x 10^6)	1.58 (0.114)
# of seats in food court	**3090.74 (668.26)**	**4.63 (0.000)**
# of mall levels	**6.19 x 10^5 (3.21 x 10^5)**	**1.93 (0.055)**
Years since last renovation	-5.71 x 10^4 (3.88 x 10^4)	-1.47 (0.142)
Outparcel space	6.50 x 10^5 (4.75 x 10^5)	1.37 (0.172)
Distance to nearest mall	**1.88 x 10^4 (9425.40)**	**2.00 (0.046)**
Distance to nearest city	-5934.22 (4927.17)	-1.20 (0.229)
Mall classification: value retail	-2.33 x 10^7 (2.13 x 10^7)	-1.09 (0.275)
Mall classification: lifestyle	-2.13 x 10^7 (1.40 x 10^7)	-1.52 (0.130)
Outdoor center	1.48 x 10^7 (9.19 x 10^6)	1.62 (0.107)

Figure 7: Results from OLS regression of visitor traffic on non-anchor size and anchor quality. Significant variables shown in **bold**. See Appendix 5 for a definition of all regressors included in this figure and the following figure.

The regression in which non-anchor sales per square foot is the dependent variable reveals that there is a positive relationship between this variable and high and medium anchor quality levels as well as non-anchor size, as shown in the results of this regression in Figure 8. As discussed in the previous sections, the effect of non-anchor size on the developer's anchor-quality choice follows directly from its effect on mall traffic and store profits; hence the importance of these results, which verify the behavior predicted by the theoretical model in Propositions 1 and 2 for the intermediate stages of the game.

In addition to demonstrating that the predicted relationships between the intermediate variables (mall traffic and profits) and the key strategic variables of interest (anchor quality and non-anchor size) are robust to the inclusion of multiple relevant control variables, Figures

Variable	Coefficient (std. error)	T statistic (significance)
Intercept	**200.19 (60.38)**	**3.32 (0.001)**
NA size effect	**1.256 x 10^{-4} (3.03 x 10^{-5})**	**4.15 (0.000)**
Effect of "anchor quality = H"	**148.87 (17.31)**	**8.60 (0.000)**
Effect of "anchor quality = M"	**47.80 (11.83)**	**4.04 (0.000)**
Population (10 mile radius)	**3.55 x 10^{-5}(8.10 x 10^{-6})**	**4.38 (0.000)**
Income (10 mile radius)	2.49 x 10^{-4}(2.73 x 10^{-4})	0.91 (0.361)
Age (10 mile radius)	0.415 (1.415)	0.29 (0.769)
Herfindahl index	**311.48 (138.77)**	**2.24 (0.025)**
# of seats in food court	**0.0303 (0.015)**	**2.02 (0.044)**
# of mall levels	2.604 (6.53)	0.40 (0.690)
Years since last renovation	**-2.64 (0.789)**	**-3.34 (0.001)**
Outparcel space	**-25.204 (9.413)**	**-2.68 (0.008)**
Distance to nearest mall	0.193 (0.174)	1.11 (0.267)
Distance to nearest city	-0.085 (0.084)	-1.01 (0.313)
Mall classification: value retail	-3.658 (72.49)	-0.05 (0.960)
Mall classification: lifestyle	1.742 (23.90)	0.07 (0.942)
Outdoor center	**54.27 (17.41)**	**3.12 (0.002)**

Figure 8: Results from OLS regression of non-anchor sales per square foot on non-anchor size and anchor quality.

7 and 8 also show that some of these controls have statistically significant relationships with mall traffic and profits as well.

Of greatest interest is the Herfindahl index variable, which represents to what extent the square footage of the mall is concentrated in a small number of stores. I calculate the Herfindahl index for each mall using the following equation:

$$H_i = \sum_{a=1}^{A} (\frac{GLA_a}{GLA})^2 + N(\frac{GLA_n}{GLA})^2$$

in which:

H_i = Herfindahl index for mall i

GLA_a = GLA of anchor store a

GLA_n = GLA of a "representative" non-anchor store[6]

GLA = Total mall GLA

N = Total number of non-anchor stores

The positive and significant coefficient associated with the Herfindahl index variable demonstrates that an increasing degree of dominance of a mall's retail space by a small number of anchor stores (with non-anchor GLA being held constant) has a positive effect on mall traffic and non-anchor store profits, providing additional empirical evidence for the general theory that anchor stores generate positive demand externalities.

Furthermore, it is also interesting to note the positive relationship between mall traffic and

[6]GLA for individual non-anchor stores is not available in the data set.

profits and a group of variables including population, number of mall levels, and number of food court seats. These variables can influence the utility that consumers expect to receive as part of a trip to the mall. Higher population density in the surrounding area as well as a higher number of mall levels are typical of malls in large urban areas, which tend to be surrounded by additional shopping and entertainment options in close proximity. These additional options may in turn add to consumer's expected utility from a mall visit: according to a survey conducted by Christiansen et al. (1999), "mall locations where there were multiple opportunities for the consumer to engage in diversionary activities were felt to provide greater entertainment value." Likewise, the size of a mall's food court (a centrally-located cluster of quick-service restaurants located within many regional malls), as measured by number of seats, represents another potential source of consumer utility from a mall trip not captured by the theoretical model.

6.2 Determinants of mall's anchor store quality decision

I now consider the determinants of the anchor quality choice variable itself. I examine whether non-anchor store size has a positive and concave relationship with the likelihood of a mall developer choosing a high or medium anchor quality level instead of the default low level, as predicted in Proposition 3 in the theoretical model.

There exists the possibility that the exogeneity of non-anchor GLA presumed by the theoretical model may not hold in actuality, given that the iterative process of mall development may result in limited adjustments to total non-anchor size once anchor stores are chosen, and that non-anchor size may be dependent on unobserved market conditions. I correct for potential endogeneity using the control function approach described by Petrin and Train (2006). I use the number of parking spaces in the mall as an instrument: of the variables in the data set, this variable has the strongest correlation with non-anchor GLA (even when controlling for anchor GLA), but is considerably less likely to be plausibly correlated with unobserved market conditions that may affect anchor quality. Thus, I run a regression of non-anchor size on the instrument variable of parking space ($GLA_{Ni} = \alpha + \beta ParkSpaces_i + \varepsilon_i$) and include the residuals ε_i from this regression in the following step.

I use a multinomial logit choice model specification to model the developer's choice between the three anchor store quality levels described in section 3. The index of each choice is represented by $j \in \{H, M, L\}$, with the low quality level as the default choice. The payoff function for each move (anchor-store quality choice j) taken by each mall (i) is specified as follows:

$$\Pi_{ij} = \alpha_j + \beta_{j1} GLA_{Ni} + \beta_{j2} GLA_{Ni}^2 + \beta_j X_i + \xi_i + \varepsilon_{ij}$$

in which:

GLA_{Ni} = Total non-anchor GLA

X_i = Vector of mall-specific regressors (same as in previous regression) including endogeneity correction residuals

$\xi_i \sim (0, \sigma^2)$ = Market-specific error term (observable to all firms)

ε_{ij} = Mall-specific unobservables affecting utility for mall i from choice j

Since each mall developer's private information ε_{ij} is independent and identically distributed across firms and anchor-quality choices with a type 1 extreme value distribution, the equilibrium probability of firm i choosing quality level q_H or q_M in market n is as follows:

$$P_{inj} = \frac{exp(\alpha_j + \beta_j X_i + \xi_n)}{1 + \sum_{k \neq j} exp(\alpha_k + \beta_k X_i + \xi_n)}$$

The probability of choosing the default quality level q_L is as follows:

$$P_{inj} = \frac{1}{1 + \sum_{k \neq j} exp(\alpha_k + \beta_k X_i + \xi_n)}$$

The coefficient estimates for the non-anchor size effect linear and quadratic terms, which are positive and negative, respectively, show that non-anchor size has a positive and concave relationship with the likelihood of choosing high or medium anchor quality, as predicted by Proposition 3. This result is similar to the positive and concave relationship shown in the previous section between non-anchor size and mall traffic. The coefficient estimates for the effects of selected variables on the likelihood of choosing high (H) or medium (M) anchor quality are shown in Figure 9; the full regression results, including additional significant controls, are shown in Appendix 6.

Variable	**Coefficient (std. err.)**	**Z-statistic (significance)**
Intercept (H)	**-8.23 (2.21)**	**-3.71 (0.000)**
Intercept (M)	-2.62 (1.67)	-1.56 (0.118)
NA size effect (H)	**1.66×10^{-5} (2.43×10^{-6})**	**6.84 (0.000)**
NA size effect (M)	**1.24×10^{-5} (1.99×10^{-6})**	**6.25 (0.000)**
NA size^2 effect (H)	**-5.26×10^{-12} (1.56×10^{-12})**	**-3.37 (0.001)**
NA size^2 effect (M)	**-4.85×10^{-12} (1.37×10^{-12})**	**-3.54 (0.000)**
MSA mean anchor quality (H)	**-0.9178 (0.468)**	**-1.96 (0.050)**
MSA mean anchor quality (M)	-0.1883 (0.3444)	-0.55 (0.584)
PS residual effect (H)	**-1.17×10^{-5} (1.77×10^{-6})**	**-6.64 (0.000)**
PS residual effect (M)	**-1.02×10^{-5} (1.51×10^{-6})**	**-6.78 (0.000)**

Figure 9: Results from multinomial logit regression of anchor quality on non-anchor size with endogeneity correction residuals ("PS residual effect") included.

One independent variable shown in Figure 9 that was omitted from the previous regressions is "MSA mean anchor quality", which represents the mean anchor quality rating of all other malls in the same MSA (metropolitan statistical area), in which anchor quality ratings of high, medium, and low are coded as 1, 2, and 3, respectively. The coefficient estimate for this variable's effect on the likelihood of choosing high quality is negative and significant, suggesting that the presence of other high-quality anchor malls (which may be indicative of unobservable factors within the MSA other than the included controls which influence demand for high-quality goods) increases the likelihood that a mall will choose a high-quality anchor. However, this explanation does not account for the effect of having nearby malls that compete for the same upscale segment of consumers; it seems necessary to consider the effects not just of all malls in the MSA, but of the nearest competing mall. This analysis is the subject of the following section.

6.3 Full model with competitive effects

In this section, I extend the basic multinomial logit choice model described in the previous section to account for competitive interactions between neighboring centers. This extended model is based on previous work by Seim (2006) and Zhu and Singh (2007).

The data can be partitioned into N markets $(1....N)$ with 2 competing malls ("firms") in each market, using n and i to denote the indices of each market and mall, respectively: $i \in \{1, 2\}$. The payoff function for each move (anchor-store quality choice j) taken by each mall (i) in each market (n) is specified as follows:

$$\Pi_{inj} = \alpha_j + \beta_1 GLA_{Ni} + \beta_2 GLA_{Ni}^2 + \beta_j X_{in} + \sum_{j'=1}^{J} \delta_{jj'} E(A_{i'j'}) + \xi_n + \varepsilon_{inj}$$

in which:

GLA_{Ni} = Total non-anchor GLA

X_{in} = Vector of mall-specific regressors (from previous regression)

$A_{i'j'}$ = Binary variable equal to 1 if other mall in market (i') chooses quality level j', 0 otherwise

$\delta_{jj'}$ = Coefficient that captures effect of other mall's choice of j' on utility if current mall chooses j

$\xi_n \sim (0, \sigma^2)$ = Market-specific error term (observable to all firms)

ε_{inj} = Mall-specific unobservables affecting utility for mall i from choice j

Again, as each firm's private information ε_{inj} is I.I.D. across firms and anchor-quality choices with a type 1 extreme value distribution, the equilibrium probability of firm i choosing quality level q_H or q_M, or quality level q_L, respectively, in market n is as follows:

$$P_{inj} = \frac{exp(\alpha_j + \beta_j X_{in} + \sum_{j'=1}^{J} \delta_{jj'} E(A_{i'j'}) + \xi_n)}{1 + \sum_{k \neq j} exp(\alpha_k + \beta_k X_{in} + \sum_{j'=1}^{J} \delta_{kj'} E(A_{i'j'}) + \xi_n)}$$

$$P_{inj} = \frac{1}{1 + \sum_{k \neq j} exp(\alpha_k + \beta_k X_{in} + \sum_{j'=1}^{J} \delta_{kj'} E(A_{i'j'}) + \xi_n)}$$

In the above model, the parameters to be estimated are (α,β,δ). To simplify the parameter space, $\delta_{jj'} = 0$ if either j or j' is equal to the low quality level q_L.

The parameters are estimated using the maximum-likelihood approach. During each iteration, the probability terms (P) are calculated for each market using a fixed-point algorithm that converges to a Bayesian Nash equilibrium in which each of the 2 malls in that market has choice probabilities that represent a best response to each other's probabilities. To estimate this model, I consider the subset of the data in which 2 malls can be identified as mutually "competing" with each other. Using a field in the data set in which each mall's closest competitor is identified, I observe that a total of 293 pairs of malls mutually identify each other as their nearest competitor, thus defining 293 unique markets with 2 firms in each market.

Figure 10 shows the results of the estimation for the likelihood model with competitive effects included. These results show that the positive and concave relationship between anchor quality and non-anchor size observed in the previous models exists even when competitive effects are accounted for, as the coefficient estimates for the non-anchor size linear terms are again positive and significant and the coefficient for the quadratic terms are negative and significant. Furthermore, there is evidence that the anchor quality choices of competing malls has an effect on a mall's likelihood of choosing the high anchor quality level (though not the medium anchor quality level). The probability of choosing high anchor quality is affected positively by the rival mall's choice of medium anchor quality, but negatively by the rival mall's choice of high anchor quality. This suggests that the presence of another high-quality-anchor mall acts as a deterrent against choosing high anchor quality, perhaps due to the possibility that two such malls in close proximity oversaturates the limited market for expensive goods offered by high-quality anchors. However, the positive coefficient for the effect of medium anchor quality on the rival's choice of high anchor quality may be explained as follows: if a mall chooses medium anchor quality, this establishes that at least some demand for goods other than those offered by low-quality anchors exists in the area, while still presenting the rival mall with an opportunity to differentiate itself by choosing high anchor quality.

The results of this empirical analysis demonstrate that the proposed inverse-U-shaped relationship between anchor quality and non-anchor size is not only present in a cross-section of U.S. malls, but that this relationship is robust to the inclusion of multiple mall-specific and market-specific control variables, an endogeneity correction, and inter-mall competitive effects.

Variable	Coefficient (std. err.)	T-statistic (significance)
Intercept (H)	**1.3475 (0.3960)**	**3.4028 (0.001)**
Intercept (M)	0.0031 (0.3487)	0.0089 (0.993)
NA size effect (H)	**2.0422 (0.7025)**	**2.9073 (0.004)**
NA size effect (M)	**1.0173 (0.2831)**	**3.5939 (0.001)**
NA size^2 effect (H)	**-0.2455 (0.0223)**	**>10 (0.000)**
NA size^2 effect (M)	-0.1681 (0.1184)	-1.4205 (0.156)
Competitive effect (H→H)	**-0.7383 (0.0633)**	**>10 (0.000)**
Competitive effect (H→M)	-0.1450 (3.5821)	-0.0404 (0.968)
Competitive effect (M→H)	**1.8180 (0.1919)**	**9.4759 (0.000)**
Competitive effect (M→M)	2.8457 (4.5633)	0.6236 (0.533)
PS residual effect (H)	**-1.7219 (0.4155)**	**-4.1442 (0.000)**
PS residual effect (M)	**-2.4812 (0.4385)**	**-5.6580 (0.000)**

Figure 10: Results from multinomial logit regression of anchor quality on non-anchor size with endogeneity correction and competitive effects included. "Competitive effect (M→H)" represents the coefficient that determines the effect that the probability of a competing mall choosing anchor quality level q_M has on a mall choosing quality level q_H.

7 Conclusion and future work

The goals of this paper have been to present a theoretical model capturing competitive interactions between anchor and non-anchor stores in a developer-controlled mall, to propose a relationship between mall size, anchor quality, and variables relating to mall performance (traffic and store profits), and to verify it empirically using data from the shopping-center industry. The results have important implications for mall developers, particularly those who are currently faced with the task of redeveloping an existing mall or replacing vacated anchor spaces. In doing so, they must consider how the retail mixes of their properties - as influenced by the quality of their anchor stores and the number and variety of non-anchors - impact price competition and shopper behavior. The relationships demonstrated by this paper must be taken into account in conjunction with other analyses that are typically part of the shopping-center development process, such as analysis of the income patterns and alternate shopping options in the center's trade area, which can alter the extent to which consumers act in ways predicted by this model.

This paper has also aimed to present a non-trivial variation on the traditional upstream manufacturer and downstream retailer paradigm from the vertical control literature. Analyzing the effects of mall size as well as additional market-level and store-level factors on the various parties' competitive actions within the shopping-center framework should yield insights that generalize beyond malls. A major goal of this paper is to demonstrate how stores in a "retail cluster" - of which a shopping mall is one example - balance the need to compete with each other for their share of the cluster's aggregate profits with the need to attract as many consumers to the cluster in the first place, increasing profits for all stores. Modeling the choices made by a central planner in other settings (i.e. a city planner in charge of developing a central business district, or proprietor of an online "virtual mall") to manage these two components of intra-cluster competition may be of further interest to the field of vertical control theory.

This framework presents multiple directions for additional research. The theoretical model can be expanded to include more flexible contracts similar to those mentioned elsewhere in the vertical control literature, in which stores are able to negotiate arrangements other that one in which the developer acts as a residual claimant. A potential stream of research identified in the empirical section of this paper that may result in enhancements to the theory model relates to non-traditional anchors such as restaurants and entertainment destinations; as numerous struggling malls are currently being redeveloped, such anchors are steadily growing in number, the most notable being the Nickelodeon Universe amusement park that occupies the center of the largest mall in the United States, the Mall of America in Bloomington, Minnesota. While the current theoretical model defines consumer utility from a mall shopping trip in terms of valuation of goods and price, it could be extended to include utility from food- and entertainment-oriented anchors and non-anchors alike. What makes it challenging to both theoretically model and empirically validate these effects is formally defining the value of "entertainment" in a shopping-center context; Christiansen et al. (1999) define entertainment in a shopping context as "some activity or behavior that provided a diversion or relief from normal day-to-day activities" including shopping, and attempt to quantify the appeal of various mall entertainment options using a 38-question survey. Further advances in research related to this specific aspect of malls could lead to meaningful extensions of the model proposed in this paper.

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Appendix 1: List of mall classifications in dataset

The following is a list of all shopping-center categories included in the dataset provided by the Directory of Major Malls (DMM):

- **Super-regional centers**: Retail centers (typically enclosed malls) with general leasable area (GLA) of above 800,000 square feet.
- **Regional centers**: Retail centers (typically enclosed malls) with GLA between 400,000 and 800,000 square feet.
- **Community centers**: Centers with GLA between 100,000 and 350,000 square feet.
- **Lifestyle centers***:* Centers with an "emphasis on lifestyle" (typically outdoor malls with upscale amenities).
- **Power centers**: Centers with at least 2 big-box chain retail stores.
- **Value retail centers**: Outlet- and off-price-focused centers.
- **Entertainment centers**: centers that mix retail with theatres and entertainment attractions, with an emphasis on the latter.

Appendix 2: Derivation of price equilibrium

As stated in Section 4.1, the stores' profit functions are specified as follows:

$$\Pi_A = p_A P(A) M$$
$$\Pi_N = p_N P(N) M$$

The probability terms $P(A)$ and $P(N)$ are calculated by integrating the probabilities from Figure 5 across the four intervals of v (similar to the EU calculation in Appendix 4), yielding the following expressions:

$$P(A) = \frac{1}{2t}[-2p_A + 2q + \beta(-1 + p_A + p_N - q + t)]$$
$$P(N) = \frac{1}{2t}[\beta(1 + p_A - p_N - q + t)]$$

Solving first-order conditions for the stores' profit functions (after substituting p_A and p_N for the price expectation variables $\overline{p_A}$ and $\overline{p_N}$ in the M term, which are equal to actual prices in equilibrium under the rational-expectations assumption) yields the following equilibrium prices:

$$p_A = \frac{\beta - 4q + 3\beta q - 3\beta t}{5\beta - 8}$$
$$p_N = \frac{\beta(3 - q + t) + 2(q - 2(1 + t))}{5\beta - 8}$$

Throughout the model, these equilibrium prices can be substituted for the actual price variables p_A and p_N. By making these substitutions, closed-form expressions for the various components of the model ($P(A)$, $P(N)$, M, Π_A, Π_N) can be derived solely in terms of t, β and q.

Appendix 3: Boundary points

Given that v is uniformly distributed from 0 to 1, the point P_2 in Figure 3, representing the value of v at which a consumer would be ambivalent between purchasing from either store is defined as follows:

$$P_2 = \frac{1}{2t}(q - p_A + p_N + t - 1)$$

Similarly, the points P_1 and P_3, representing the values of v at which non-anchor and anchor valuation are 0, respectively, are as follows:

$$P_1 = 1 + \frac{p_N}{t} - \frac{1}{t}$$
$$P_3 = \frac{q - p_A}{t}$$

Appendix 4: Calculation of expected mall traffic

As described in Section 4.2, expected utility can be calculated for each of the 4 segments of consumers as defined by their values of v. In the following calculations, $E(U \mid N)$ and $E(U \mid A)$ are simply equal to valuation net of price as shown in Figure 3. Note that price expectation variables ($\overline{p_N}$ and $\overline{p_A}$) replace actual prices, which are unknown to consumers at this stage of the game.

$$EU_1 = EU_2 = (q - v - \overline{p_A})$$
$$EU_3 = (1 - \beta)(q - v - \overline{p_A}) + \beta(v - \overline{p_N})$$
$$EU_4 = \beta(v - \overline{p_N})$$

Since v is uniformly distributed on the unit interval across the population, the total expected number M of visitors to the mall can be calculated by integrating EU across the four intervals of v as follows:

$$M = \int_0^{P_1} EU_1 dv + \int_{P_1}^{P_2} EU_2 dv + \int_{P_2}^{P_3} EU_3 dv + \int_{P_3}^{1} EU_4 dv$$
$$= \frac{1}{4t}[2(\overline{p_A} - q)^2 - \beta(-1 + \overline{p_A}^2 - \overline{p_N}^2 + 2q + (q-t)^2 - 2t + 2\overline{p_N}(1 - q + t)$$
$$+ 2\overline{p_A}(-1 + \overline{p_N} - q + t)]$$

Appendix 5: Description of variables used in empirical section

The following list includes a description of all variables included in the regressions in Sections 6.1 and 6.2.

- **NA size**: Combined general leasable area (GLA) of the mall's non-anchor stores.
- **Effect of "anchor quality = H/M"**: Binary variable equal to 1 if the mall's highest-quality anchor has a quality rating of H or M, 0 otherwise.
- **Population (10 mile radius)**: Total population within a 10-mile radius of the mall.
- **Income (10 mile radius)**: Mean income of population within a 10-mile radius of the mall.
- **Age (10 mile radius)**: Mean age of population within a 10-mile radius of the mall.
- **Herfindahl index**: Measure of the degree to which a mall's GLA is concentrated in a small number of stores, calculated as described in Section 6.1.
- **# of seats in food court**: Total number of seats in the mall's "food court", a centralized group of food-service establishments. Variable contains 0 if the mall does not have a food court.
- **# of mall levels**: Number of floors in the mall on which stores are found.
- **Years since last renovation**: Number of years since the mall was last renovated.
- **Outparcel space**: Amount of GLA devoted to "outparcel" stores, which are located in the mall's parking lot or in another location not physically connected to the main part of the mall.
- **Distance to nearest mall/city**: Distance from the mall to the nearest competing mall or to the nearest "city" as defined by the U.S. Census.
- **Mall classification - "value retail"/"lifestyle"**: Binary variable equal to 1 if mall is in the "Value Retail" or "Lifestyle" categories as defined in Appendix 1, 0 otherwise.

- **Outdoor center**: Binary variable equal to 1 if the mall is an outdoor mall, 0 if the mall is enclosed.
- **MSA mean anchor quality**: Mean anchor quality rating of all other malls in the mall's MSA (metropolitan statistical area).
- **PS residual effect**: Residuals from regression of GLA on number of parking spaces, included as part of the endogeneity correction described in Section 6.2.

Appendix 6: Complete anchor-choice multinomial logit regression

Variable	**Coefficient (std. err.)**	**Z-statistic (significance)**
Intercept (H)	**-8.23 (2.21)**	**-3.71 (0.000)**
Intercept (M)	-2.62 (1.67)	-1.56 (0.118)
NA size effect (H)	**1.66 x 10^{-5} (2.43 x 10^{-6})**	**6.84 (0.000)**
NA size effect (M)	**1.24 x 10^{-5} (1.99 x 10^{-6})**	**6.25 (0.000)**
NA size^2 effect (H)	**-5.26 x 10^{-12} (1.56 x 10^{-12})**	**-3.37 (0.001)**
NA size^2 effect (M)	**-4.85 x 10^{-12} (1.37 x 10^{-12})**	**-3.54 (0.000)**
Population (10 mile radius) (H)	-2.13 x 10^{-7} (1.92 x 10^{-7})	-1.11 (0.268)
Population (10 mile radius) (M)	**-4.31 x 10^{-7} (1.72 x 10^{-7})**	**-2.50 (0.012)**
Income (10 mile radius) (H)	**3.14 x 10^{-5} (6.96 x 10^{-6})**	**4.51 (0.000)**
Income (10 mile radius) (M)	1.47 x 10^{-6} (6.16 x 10^{-6})	0.24 (0.811)
Age (10 mile radius) (H)	0.187 (0.047)	0.40 (0.691)
Age (10 mile radius) (M)	-0.017 (0.035)	-0.51 (0.613)
# of seats in food court (H)	**0.0012 (0.00048)**	**-1.96 (0.050)**
# of seats in food court (M)	**0.00095 (0.00043)**	**2.18 (0.029)**
# of mall levels (H)	**1.0281 (0.1934)**	**5.32 (0.000)**
# of mall levels (M)	**0.61004 (0.1729)**	**3.53 (0.000)**
Years since last renovation (H)	-0.00916 (0.0222)	-0.41 (0.681)
Years since last renovation (M)	-0.01348 (0.0172)	-0.79 (0.432)
Outparcel space (H)	**-1.0347 (0.2797)**	**-3.70 (0.000)**
Outparcel space (M)	**-0.6158 (0.2277)**	**-2.70 (0.007)**
Distance to nearest mall (H)	-0.0026 (0.0207)	-0.13 (0.898)
Distance to nearest mall (M)	**0.0506 (0.0133)**	**3.79 (0.000)**
Distance to nearest city (H)	-0.0018 (0.0035)	-0.53 (0.597)
Distance to nearest city (M)	-0.0017 (0.0025)	-0.69 (0.493)
Mall classification: value retail (H)	-1.0305 (1.1162)	-0.92 (0.356)
Mall classification: value retail (M)	**-2.9104 (1.1035)**	**-2.64 (0.008)**
Mall classification: lifestyle (H)	-0.5129 (0.6111)	-0.84 (0.401)
Mall classification: lifestyle (M)	0.2628 (0.4331)	0.61 (0.544)
Outdoor center (H)	**-0.87402 (0.3883)**	**-2.25 (0.024)**
Outdoor center (M)	**-1.9167 (0.3077)**	**-6.23 (0.000)**
MSA mean anchor quality (H)	**-0.9178 (0.468)**	**-1.96 (0.050)**
MSA mean anchor quality (M)	-0.1883 (0.3444)	-0.55 (0.584)
PS residual effect (H)	**-1.17 x 10^{-5} (1.77 x 10^{-6})**	**-6.64 (0.000)**
PS residual effect (M)	**-1.02 x 10^{-5} (1.51 x 10^{-6})**	**-6.78 (0.000)**

Figure 11: Complete results from multinomial logit regression of anchor quality on non-anchor size with endogeneity correction residuals ("PS residual effect") included.