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Does Vertical Integration Enhance Non-Price Efficiency? Evidence from the Movie Theater Industry

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Abstract

This paper examines how integration between distribution and exhibition in the movie theater industry affects non-price efficiency. We find evidence that integrated theaters may be more efficient than independent ones at picking movies to screen and allocating seats across them. To explain our finding, we provide a model showing that the efficiency increases with a theater chain size, while the effect of vertical integration itself is ambiguous. Comparing efficiency across chains suggests that the effect of vertical integration per se is insignificant, and observed efficiency gains can be attributed to the large size of integrated theater chains.

Keywords: vertical integration, efficiency, movie theater industry.

JEL Classification: L13, L22, L82.

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1 Introduction

Vertical integration in retail markets has countervailing effects on efficiency. First, vertical mergers can eliminate double marginalization (Spengler, 1950), reduce transaction costs (Williamson, 1971; Gil, 2007), and align incentives of upstream and downstream firms (Grossman and Hart, 1986; Gil, 2009), thus helping to achieve adequate investments in marketing, demand forecasting, etc. Second, they can be intended to foreclose competitors or to secure a distribution channel for their own products, restricting consumers' access to the products of independent firms (Rey and Tirole, 2007; Hastings and Gilbert, 2005).[1] Whereas the resulting price changes have been extensively examined in the empirical literature (Brenkers and Verboven, 2006; Hortaçsu and Syverson, 2007; Gil, 2015), the impact on non-price efficiency is less explored (Chipty, 2001; Forbes and Lederman, 2010; Lee, 2013). Nevertheless, the latter can be important for consumers. For example, mergers between movie theater chains and distributors are often blamed for pushing independent movies away from screens rather than for rising admission prices.[2]

This paper examines how vertical integration affects non-price efficiency in the context of the movie theater industry. Specifically, we explore whether independent exhibitors are better than vertically integrated ones at picking movies to screen and allocating seats across these movies. We capture the efficiency of seat allocation by measuring how closely it reflects the consumer demand: a more efficient seat allocation forces fewer consumers to switch to their less preferred movie, less preferred theater, or less preferred time. Indeed, due to the practice of uniform pricing, moviegoers are predominantly affected through the mere availability of their preferred movies in their preferred theaters determined by the theater's seat allocation.

Our empirical approach to measuring how well the seat allocations across integrated and independent theaters match consumer demand is based on two main assumptions. First, consumer tastes do not change over the course of a single week. Second, theater-level demand is homogeneous across theaters in a city. Using the detailed data covering movie theaters in the largest cities in Korea, we calculate the percentage of consumers that would be turned away by each

[1] Gibbons (2005) provides an excellent literature review on the four formalizable theories of vertical integration.
[2] "Conglomerates direct Korea's film industry", *Korea Joongang Daily,* Dec 06, 2012.

theater under a given level of aggregate movie demand.

We find that integrated theaters may turn away fewer consumers than independent ones. For example, assuming that the aggregate movie demand reaches 70 percent of each theater's capacity, integrated theaters would turn away approximately 30 percent fewer consumers than independent ones, other things being equal. The results are similar when we vary the aggregate movie demand, or when we consider only geographically isolated theaters. Surprisingly, we also find that integrated theaters would turn away fewer consumers of movies released by independent distributors.

To explain our findings, we use a stylized model showing that integrated theaters allocate more seats to their own movies, but also have higher incentives to acquire movie demand information. Therefore, they might forecast demand better, and turn away fewer consumers. Moreover, the model also predicts that the incentives to acquire the movie demand information increase with a theater chain size. Given that integrated theaters typically belong to large chains, it is unclear what drives the efficiency results. We try to disentangle the effects due to vertical integration and size by exploiting the fact that there is one independent theater chain in our sample. We find that theaters of the independent chain are as efficient as the theaters of integrated chains, but are more efficient than individually owned independent theaters. This suggests that the net effect of vertical integration is insignificant, and the observed differences in efficiency are driven by the size effect.

Finally, to support the information mechanism behind the model, we exploit the length of a movie run as the proxy for the quality of demand information available to the theaters. Consistent with the model, we find that the longer a movie is on screen, the better the theaters' seat allocation for the movie reflects its demand.

This paper contributes to the empirical literature on the efficiency effects of vertical integration. In the cement industry, Hortaçsu and Syverson (2007) find that vertically integrated firms are more productive and charge lower prices. However, similar to our finding, they also show that productivity does not differ significantly between large non-integrated and large integrated firms. Vertical integration is also found to enhance efficiency, resulting in lower prices or higher product quality in other industries including airlines (Forbes and Lederman, 2010) and cable television (Chipty, 2001; Suzuki, 2009). In contrast, the removal of vertical restrains or exclusive arrangements may increase consumer welfare, as is shown by Brenkers and Verboven (2006) in the automobile, and Lee (2013) in the video game industries.

In the context of the movie theater industry vertical integration is empirically examined by Fu (2009), Hwang (2013), and Choi et al. (2015). They show that movies released by an integrated distributor are assigned more screens or stay longer in theaters owned by that distributor than other movies. We demonstrate that despite these distortions, integrated theaters may choose more efficient seat allocations.

The paper is organized as follows. Section 2 discusses the basic features of the Korean movie theater industry. Section 3 describes the data and provides summary statistics. In Section 4 we introduce the measure of efficiency of a seat allocation, and compare it across theaters. In Section 5 we develop a theoretical mechanism explaining how vertical integration enhances the efficiency of seat allocation. Section 6 concludes.

2 Movie theater industry: institutional details

The movie theater industry is composed of three vertical layers: production, distribution, and exhibition. In this study we use data from South Korea where, unlike in the US, integration between distributors and exhibitors is allowed. As a result, three corporations, CJ, Lotte, and Orion, control a large market share in both distribution and exhibition.[3] Table 1 shows that, for example, in 2009 CJ had 100 theaters with 792 screens, while 49 movies distributed by the firm attracted 45 million consumers. Overall, movies released by integrated distributors attracted more than half of the entire audience.

In the movie theater industry distributors and exhibitors of movies usually use revenue sharing contracts. Whereas the revenue sharing might differ across movies and be negotiable in the middle of the run of a movie in other countries such as the US and Spain, in Korea the terms of

[3] In July 2007 Orion's theater brand Megabox was sold to a consortium led by Australian banking group Macquarie. However, the contract guaranteed that for the next 10 years Orion will still run these theaters. Hence, we assume that during the sample period from 2005 to 2009 Megabox remained vertically integrated.

the revenue sharing contracts are fixed. For domestic movies, which are responsible for around half of the total audience size, a theater takes half of the box office after deducting taxes, and the remaining half plus additional sales from the home video market goes to a distributor, a film maker, and investors (Hwang, 2013).[4]

Another important feature of the industry is the uniform pricing of movies.[5] Admission prices may differ across times and days but are usually the same across movies and theaters in a city. For example, in Seoul in 2009 the price was approximately \$5 during weekdays and \$6 during weekends, excluding early morning shows for which admission price was \$3.

Korean movie theater industry sharply expanded in the 2000s, and by 2013 its theatrical exhibition market was the 7th largest in the world in terms of box office revenues. On average Koreans went to a movie theater 4.1 times in 2012.[6] Despite its large theatrical exhibition market, however, the market for subsequent nontheatrical release windows such as home video and pay television is abnormally small in Korea. While the revenue share of nontheatrical venues is well above 50 percent in other countries with a huge motion picture industry such as the US, UK, and Germany, nontheatrical windows account for less than 20 percent of the total revenue in Korea.[7] This feature of Korean movie theater industry magnifies the effects of integration between distribution and exhibition.

3 Data

We use data downloadable from the Korea Box Office Information System (KOBIS).[8] The first data set contains the weekly audience size of each movie that had been screened from 2005 to 2009 in seven metropolitan cities in Korea: Seoul, Busan, Incheon, Daegu, Daejeon, Ulsan, and Gwangju. Our audience data set is unique compared to the existing studies of the movie theater industry (e.g. Einav, 2007; Moul, 2007, 2008; Gil, 2009) because it contains weekdays (Monday

[4]The revenue sharing ratio is 50:50 for domestic movies and 40:60 for foreign movies in Seoul, the largest city in South Korea. It is 50:50 for all movies in other regions in Korea.

[5]Orbach and Einav (2007) provide in-depth analysis of the uniform pricing in the movie theater industry. They point out explanations based on perceived fairness, demand uncertainty, and monitoring costs.

[6]MPAA Theatrical Market Statistics 2013; Korean Ministry of Culture, Sports and Tourism press release, December 19, 2013.

[7]On the Incredibility of the Nontheatrical Market Statistics in Korea, KOFIC Issue Paper, 2012 Vol. 2.

[8]Korea Box Office Information System is accessible at http://kobis.or.kr.

through Thursday) and weekends (Friday through Sunday) audience sizes separately. In the following section we explain how we exploit this feature in the empirical analysis. The data are still aggregated across all showings during weekdays and weekends.

From KOBIS we also obtain (i) the daily screen schedule of each theater during the sample period (ii) and the number of seats in each screen of each theater. We supplement the data sets with the additional movie and theater information. Distributors and release dates of movies are available in KOBIS. The theater information such as chain, number of screens, open and close dates is collected from the Korean Film Council's website.[9]

After dropping observations of movies without weekday or weekend audience size information, and movies without distributor information, we have 781,447 theater-week-movie level observations, that are aggregated to theater-week level data with 32,854 observations.[10] The summary statistics of the theater-level weekend seat allocation and the city-level weekday audience size for movies are presented in Table 2. On average, a theater allocates approximately 960 seats or 3.7 percent of its capacity to a movie on a weekend. Some movies might not be played in a theater at all, whereas other movies might be allocated a large proportion of its screens. On average, a movie attracts 4,525 consumers in a city on weekdays of a week, that is 5.5 percent of the total movie audience size in the city.

4 Empirical Analysis

In this section we introduce a measure of efficiency of a theater's seat allocation and analyze how it varies across independent and integrated theaters. Our measure is based on a simple idea that moviegoers have their preferred theater and a preferred time when to see a movie. Moreover, the preferred theater must be independent of a movie that a consumer decides to see. For example, a consumer would not typically drive across town when the same movie is available at her preferred time in a local multiplex. Hence, when a moviegoer cannot find her preferred movie in her preferred theater in her preferred time and is forced to choose another movie, or another theater, or another time, she must experience some utility loss. We aim to evaluate the

[9]Korean Film Council is accessible at http://www.kofic.or.kr.

[10]The dropped observations include previews, special showings, and re-released movies.

number of such "turned away" consumers and use it as a proxy for the efficiency of a theater's seat allocation.

The underlying idea of our empirical approach is to compare a theater's seat allocation at a given time with a movie demand it faces. Of course, when a movie demand is low relatively to the available capacity, such as during the weekdays, the seat allocation should not matter unless some movies are completely absent from screens. So, ideally, to evaluate a number of consumers turned away from a theater we would compare its seat allocation during a high demand period with the corresponding movie demand.[11] Hence, in the empirical analysis we aim to compare seat allocation and demand during weekends. While we have detailed theater-level seat allocation data, we observe only city-level audience. To recover the theater-level weekend demand, we make use of the two key assumptions.

First, we assume that consumer tastes do not change over the course of a single week, and hence we use the weekday audience shares of movies as proxies for the weekend demand shares. Although the weekend audience is available in our data, it is endogenous to the theaters' seat allocation when demand exceeds the supply of seats, which is common during weekends. In contrast, because the movie audience size during weekdays is much lower, the audience share would not be affected by the seat allocation.

Second, we assume that unobservable demand heterogeneity across theaters in the same city is uncorrelated with the theaters' type, i.e. whether it is an integrated or independent. So, a demand share of a particular movie is the same across theaters in a city.[12] Moreover, the weekday audience data provide us only with the information on the relative movie demand – a share of consumers that would like to watch a particular movie among all the consumers who attend a theater. We simulate the aggregate movie demand by scaling the demand shares. Because we do not observe the actual level of aggregate weekend demand, we conduct the analysis for a

[11] Anecdotal evidence that we have collected from personal observations and news articles suggest that movie theaters often face excess demand. For example, during Fridays and Saturdays people are usually advised to book movie tickets well in advance, while during weekdays theaters are relatively empty. See, for example: http://www.breaknews.com/sub_read.html?uid=534447

[12] Movies are typically marketed nation-wide, and hence it is unlikely that many consumers are affected by in-theater advertisement. Moreover, evidence suggests that consumers choose which movie to see before actually attending a theater (Davis, 2006).

range of scale factors.

Summarizing the above, in the empirical analysis we use (i) the share of seats allocated to a movie by a theater instead of the actual number of seats, (ii) the scaled weekday audience share of each movie as a proxy for the weekend movie demand faced by each theater. We provide estimates for scale factors for the aggregate movie demand faced by theaters ranging from 50 to 100 percent of seats. Focusing on seat and demand shares allows us to capture the idea that movies compete for the limited time on screen, and isolate the effects of strategic changes in the seat allocation from the mechanical effects of changes in the aggregate number of seats.

Suppose that the aggregate demand reaches κ percent of each theater's capacity. We calculate the number of consumers that would be turned away from a theater as a percentage of an aggregate demand the theater faces. To obtain an estimate of consumers turned away by theater j operating in city m during weekends of week t, we compare the theater's weekend seat share for movie i, $Seat\,Share_{ijmt}$, and its weekday demand share, $Demand\,Share_{imt}$, scaled by κ. We call this variable $Unserved_{jmt}(\kappa)$, given by

$$Unserved_{jmt}(\kappa) = \frac{1}{\kappa} \sum_{i} \max \left\{ \kappa\, Demand\,Share_{imt} - Seat\,Share_{ijmt}, 0 \right\},$$

where the summation is across the movies on screen in city m and week t. For example, suppose there are two movies on screens in a city, and each theater faces an aggregate demand on weekend equal to 80 percent of its total number of seats. Suppose also that the demand share of each movie is 50 percent. Then a theater that allocates all seats to the first movie turns away 50 percent of consumers, and a theater that allocates 80 percent of seats to the first movie and rest to the second, turns away 25 percent of consumers.

4.1 Comparing efficiency across independent and integrated movie theaters

First, we compare the percentage of consumers turned away from independent and integrated theaters. Table 2 reports the descriptive statistics of the fraction of unserved consumers in independent and integrated theaters separately, assuming the aggregate demand reaches 70 percent of each theater's seats ($\kappa = 0.7$). The striking observation is that on average integrated theaters would turn away much fewer consumers (19.6 percent) than independent ones (40.2 percent). Of course, the difference can be attributed to other theaters' characteristics, most importantly the number of screens, which affects a theater's flexibility in allocating seats, and hence its ability to match the demand. The upper two panels of Figure 1 display the histograms of the percentage of unserved consumers in independent and integrated theaters with 8 screens when $\kappa = 0.7$.[13] Integrated theaters with 8 screens would still turn away fewer consumers than independent ones. On average they would turn away 18.2 percent of consumers, whereas independent theaters would turn away 21.4 percent, and the difference is statistically significant. We confirm this pattern by the regression analysis using the entire data and controlling for the number of screens. For κ ranging between 0.5 and 1, we estimate

$$\ln Unserved_{jmt}(\kappa) = \beta_0 + \beta_{VI}\, VI\, theater_j + \mathbf{x}_{jt}\beta_{Control} + u_{jmt}, \tag{1}$$

where $VI\, theater_j$ is equal to one if theater j is integrated and zero otherwise, and vector $\mathbf{x}_{jt}$ includes the number of screens in the theater and time index.[14]

Because we estimate (1) for a range of κ's, we summarize the results graphically in the upper panel of Figure 2. The figure shows the estimated values of β_{VI}, along with 95 percent confidence bands for each κ. The estimates are always negative and statistically significant, implying that integrated theaters indeed would turn away fewer consumers for each level of aggregate demand. For example, given the same number of screens and assuming that the demand reaches 70 percent of each theater's capacity, we estimate that integrated theaters would turn away roughly 27 percent fewer consumers than independent ones.[15]

4.2 Geographically isolated theaters

Here, we address one potential problem with our approach. Suppose consumers are indifferent

[13] Theaters with 8 screens are the most common in our data. In the Appendix, Figure A2 provides the distribution of theaters by the number of screens, and Figure A1 the histograms for theaters with 6 to 10 screens.

[14] In fact, simply comparing the averages across theaters and weeks may yield the well-known Simpson's paradox, although it does not actually occur in our data. See Appendix I.

[15] Here and further in the text we report the transformed dummy variable's coefficients, $\beta^* = 100\left[\exp\left\{\beta - \frac{1}{2}v(\beta)\right\} - 1\right]$, where β is the OLS estimate and $v(\beta)$ is its standard error, see Kennedy (1981). Estimated coefficients and standard errors for $\kappa = 0.7$ are provided in Table A1 in the Appendix.

between two theaters because they are close to each other. Then, for example, one theater might specialize in blockbusters and the other in art-house movies, and consumers might choose where to go based on the movie they want to see. Although there is no inefficiency in this example, our analysis would suggest that a substantial fraction of consumers is turned away from each theater. We address this concern by comparing seat allocation of geographically isolated independent and integrated theaters. Consumers who live close to these theaters and whose preferred movies are not screened may have to take a costly travel to other theaters or watch other movies. Hence, when seat allocations of isolated theaters do not match the demand, the inefficiency is significant.

We define isolated theaters as the ones that do not have any other theater within a given radius. Because Korean movie theater market is densely populated (Kim et al., 2015), for our definition we use radii ranging from 1 kilometer to 2 kilometers. Assuming that the aggregate movie demand reaches 70 percent of each theater's capacity, we estimate (1) with observations of isolated theaters only. Estimation results in Table 3 show that, consistent with previous findings, fewer consumers would be turned away from integrated than from independent isolated theaters. For instance, when 1.2 kilometer is used as the radius there are 32 integrated and 10 independent isolated theaters, and the fraction of consumers that would be turned away is 35 percent lower in integrated theaters compared to independent ones.

4.3 Comparing efficiency using independent movies only

Although the above analysis suggests that integrated theaters choose more efficient seat allocation than independent theaters, it is unclear how consumers of movies of independent and integrated distributors are affected. For instance, one can think that integrated theaters serve more consumers of their own movies, but are turning away more consumers of movies of independent distributors. Restricting the analysis to independent movies only, we compute the percentage of unserved consumers of these movies:

$$Unserved^{Ind}_{jmt}(\kappa) = \frac{\sum_{i \in \mathcal{I}_{mt}} \max\{\kappa \, Demand\, Share_{imt} - Seat\, Share_{ijmt}, 0\}}{\kappa \sum_{i \in \mathcal{I}_{mt}} Demand\, Share_{imt}},$$

where $\mathcal{I}_{mt}$ is a set of independent movies on screen in city m and week t.

Surprisingly, we find that despite the potential distortion (e.g. Fu, 2009; Hwang, 2013; Choi et al., 2015), vertically integrated theaters would turn away significantly fewer consumers of independent movies than independent theaters. The lower panels of Figure 1 show the corresponding histograms for independent and integrated theaters with 8 screens, when the aggregate demand reaches 70 percent of each theater's seats. Integrated theaters would turn away 21.3 percent of independent movie viewers on average, and the figure goes up to 23.8 percent in independent theaters. We confirm this observation using $\ln Unserved^{Ind}_{jmt}(\kappa)$ as a dependent variable in (1). The estimates of β_{VI} are reported in the lower panel of Figure 2. The pattern is essentially the same. For example, given the same number of screens and assuming that the demand reaches 70 percent of a theater's seats, we find that integrated theaters would turn away 21 percent fewer consumers of independent movies than independent theaters, and the difference is statistically significant.

The above result is robust to a potential endogeneity problem: because integrated theaters might screen their own movies during popular hours more often, even the weekday movie audience can be endogenous to the seat allocation. Hence, we might be overestimating the demand for integrated movies. However, even though the demand for independent movies is underestimated, if we compare only independent movies then the relative demand shares among them remain unbiased. Hence, our finding that integrated theaters turn away fewer consumers of independent movies cannot not be due to the potential overestimation problem.

Finally, an interesting implication of our results is that vertically integrated theaters in fact might benefit independent distributors by allowing more consumers to watch their movies. This is in sharp contrast to the generally accepted view that vertical mergers hurt competitors.

5 Why are integrated movie theaters more efficient?

In this section we develop a stylized model explaining how integration between distributors and exhibitors of movies affects their incentives, and highlighting a natural alternative explanation for the efficiency of integrated theaters – large size of integrated chains. We exploit the existence of a large independent theater chain in our data to try to disentangle the effect of vertical integration from the effect of chain size on the efficiency of theaters' seat allocations. Finally, our model explains differences in efficiency of theaters' seat allocations by their differences in demand information: integrated and large theater chains have higher incentives to acquire the demand information. We validate the information mechanism behind the model by using a length of a movie run as a proxy for the quality of demand information available to theaters.

5.1 Theoretical mechanism

There are two movies and a movie theater chain that operates n theaters. Each theater is located in a separate local market and faces the same demand. So, parameter n simply scales the chain's revenues. Movie demand is uncertain: the chain believes that demand q_j for each movie j is independently drawn from distribution $P(q_j)$. The chain can acquire information by observing two noisy demand signals, one for each movie. The available signal pairs are parametrized by their accuracy $\eta \geq 1$. A signal of accuracy η is a random variable $\hat{Q}_j^\eta$ with conditional distribution $F^\eta(\hat{q}_j|q_j)$. The accuracy of a signal captures how informative it is about the movie demand. Following the approach of Persico (2000) we say that signal $\hat{Q}^\theta$ is *more accurate* than signal $\hat{Q}^\eta$ if

$$T_{\eta,\theta,q}(\hat{q}) = F^{\theta^{-1}}\left(F^\eta(\hat{q}|q)|q\right) \tag{2}$$

is nondecreasing in q for each $\hat{q}$. Intuitively, $T_{\eta,\theta,q}(\hat{q})$ is the transformation of the original signal such that the transformed signal is more correlated with the underlying state q. We let signals with higher η be more accurate, and $F^\eta(\hat{q}_j|q_j)$ be differentiable with respect to η.

To capture the idea that demand uncertainty is proportional to the expected demand we assume that, given realization $\hat{q}_j$ of signal of accuracy η, the conditional distribution of demand is:

$$P^\eta(q_j|\hat{q}_j) = G^\eta\left(\frac{q_j - \hat{q}_j}{\hat{q}_j}\right), \tag{3}$$

where distribution $G^\eta(x)$ has zero mean and log-concave density $g^\eta(x)$. Hence signal $\hat{q}_j$ is the expected movie demand. To understand the information structure it is instructive to think of a special case when $G^\eta(x)$ is normal with zero mean and standard deviation $1/\eta$. Then, conditional on a signal realization demand is normally distributed with mean equal to the value of a signal and coefficient of variation equal to $1/\eta$.

First, consider the decision problem of the chain after observing the realizations of the two signals. Given the posterior distributions of demands, the chain allocates seats of each of its theaters across movies. Because theaters of the chain are symmetric, we simply let s_j denote the number of seats allocated to movie j in each theater. The chain chooses s_1 and s_2 such that $s_1 + s_2 \leq 1$, where its total number of seats is normalized to one. Distributors and the chain use a fixed revenue sharing contract: a fraction λ of the box office goes to the chain, and the rest, $1 - \lambda$, goes to a distributor. We normalize the admission price to one. Given a seat allocation and demands, the revenue is

$$\pi(s_1, s_2, q_1, q_2) = n \left[\delta_1 \min\{s_1, q_1\} + \delta_2 \min\{s_2, q_2\}\right],$$

where δ_j is equal to $\lambda < 1$ if the chain is not integrated with distributor j, and equal to 1 otherwise. The chain is integrated with at most one distributor. Given the signals, it solves

$$\max_{s_1, s_2} \mathbb{E}^{\eta}\left[\pi(s_1, s_2, q_1, q_2) | \hat{q}_1, \hat{q}_2\right]$$

subject to $s_1 + s_2 \leq 1$. The first order condition is

$$\delta_1 \left(1 - P^{\eta}(s_1 | \hat{q}_1)\right) = \delta_2 \left(1 - P^{\eta}(s_2 | \hat{q}_2)\right). \quad (4)$$

Hence, if the chain is independent, then the probability that demand for a movie exceeds the supply of seats must be equal across movies. If the chain is integrated with one of the distributors, then the integrated movie is less likely to face an excess demand than an independent one. The intuition is that an integrated chain is willing to trade more than one expected viewer of an independent movie for a single expected viewer of an integrated one. Conditions (4) and (3) immediately yield the following characterization of optimal seat allocation.[16]

[16] All proofs are relegated to the Appendix.

Proposition 1. *An independent chain allocates seats proportionally to the observed signals* $\hat{q}_1$ *and* $\hat{q}_2$*, i.e. for each movie* j *we have* $s_j = \frac{\hat{q}_j}{\hat{q}_1+\hat{q}_2}$*. If a chain is integrated with distributor* j*, then it allocates more seats to movie* j *and less seats to movie* k *than in the corresponding proportional allocation, i.e. we have* $s_j > \frac{\hat{q}_j}{\hat{q}_1+\hat{q}_2}$*, and* $s_k < \frac{\hat{q}_k}{\hat{q}_1+\hat{q}_2}$*.*

According to Proposition 1, independent chains allocate equal number of seats to movies with the same relative demand, whereas integrated chains allocate more seats to their own movies. This is a *distortion effect* of vertical integration. It implies that, other things being equal, integrated chains turn away on average more consumers than independent chains.

Now we examine the chain's incentives to acquire demand information. Let $s_j^{\eta,\hat{q}_1,\hat{q}_2}$ be the optimal number of seats allocated to movie j upon observing signals $\hat{q}_1$ and $\hat{q}_2$ of accuracy η. Denote the ex ante expected revenue by

$$V(\eta) = \iiiint_{\mathbb{R}_+} \pi(s_1^{\eta,\hat{q}_1,\hat{q}_2}, s_2^{\eta,\hat{q}_1,\hat{q}_2}, q_1, q_2) dF^{\eta}(\hat{q}_1|q_1) dF^{\eta}(\hat{q}_2|q_2) dP(q_1) dP(q_2).$$

Suppose that increasing accuracy of signals has constant marginal cost $c > 0$. Before observing realizations of signals and allocating seats, the chain chooses the signal accuracy solving

$$\max_{\eta \geq 1} V(\eta) - c\eta, \tag{5}$$

Information acquisition can represent an effort to analyze the potential movie audience, the box office success of similar movies, the optimal scheduling of movies etc.

Proposition 2. *An integrated chain chooses more accurate signals than an independent one. Moreover, signal accuracy is increasing in chain size* n*.*

In addition to the effect of chain size on information acquisition, Proposition 2 provides a novel *information effect* of vertical integration – vertically integrated chains have stronger incentives for acquisition of demand information. The result is based on the analysis of the marginal value of information acquisition by Persico (2000) applied to our model of seat allocation. The intuition is the following. When an integrated chain allocates less seats to a movie than demanded and, as a result, has to turn away some consumers, it looses 1 in profits per each turned away consumer of its own movie, and λ per each turned away consumer of movies of other distributors. However, an independent chain looses only λ per turned away consumer of each movie. In other words, because integrated firms receive the entire box office of their own movies, whereas independent ones share the proceeds from the ticket sales with the distributors, integrated chains internalize the effects of improved demand forecasting. Hence, they have higher incentives to invest in information acquisition.

Collecting our results, we provide two alternative explanations of the observed efficiency of integrated theaters. First, efficiency gains due to the information effect may outweigh losses due to the distortion effect. Better information allows integrated theaters to match demand better, and hence can lead to higher efficiency. In this case, vertical integration is efficient per se. Second, incentives for information acquisition are also increasing in chain size. In our data integrated theaters belong to large chains that consist of multiple theaters in multiple cities, while most of independent theaters are individually owned. Therefore, integrated theaters can be more efficient on average, even when vertical integration is inefficient per se.

5.2 Disentangling effects of vertical integration and size

As argued above, the observed differences in efficiency can also be attributed to the size effect. To shed light on the efficiency of vertical integration per se, we exploit a presence of a single independent theater chain, Cinus, in our sample. As Table 1 shows, Cinus is a large chain that operated 25 multiplex theaters in 2009. Therefore, the size effect suggests that theaters of Cinus would be more efficient than individually owned independent theaters, turning away fewer consumers. Moreover, if vertical integration is inefficient per se, then the observed difference in the efficiency between independent and integrated theaters is entirely due to the size effect, and theaters of Cinus would be more efficient than the theaters of integrated chains. On the other hand, if vertical integration is efficient, then larger size of integrated chains only amplifies this effect. Then, theaters of Cinus would be less efficient than the theaters of integrated chains. Finally, if the net effect of vertical integration is insignificant, then theaters of Cinus and theaters of integrated chains would have similar efficiency.

To address this question, we compare theaters of Cinus with individually owned independent theaters and theaters of integrated chains separately, assuming that the aggregate movie demand reaches 70 percent of each theater's capacity. Estimates reported in Table 4 suggest that individually owned independent theaters would turn away more consumers than theaters of Cinus: the fraction of unserved consumers at theaters of Cinus is 37 percent lower than at individually owned independent theaters. Interestingly, however, there is no statistically significant difference between theaters of Cinus and theaters of integrated chains. This suggests that the net effect of vertical integration is insignificant, and the observed differences in efficiency are driven by the size effect.

5.3 The effect of demand information on seat allocations

We conclude this section by validating the information mechanism behind the model: vertically integrated and larger theater chains allocate seats more efficiently because they have better information about movie demand. However, the quality of information is not observable and hence cannot be directly linked to the efficiency of seat allocations. To pinpoint the information mechanism, we exploit the variation in the time that movies spend on screens. Arguably, movie demand is the most uncertain during the release week. After the movie begins its run, theaters get better and better estimate of demand by observing the realized audience. Hence, a seat share of a movie should move closer to its demand share, the longer the movie is on screen.

In order to address the validity of the information mechanism proposed in the model, we estimate the following regression

$$|Seat\,Share_{ijmt} - Demand\,Share_{imt}| = \delta_0 + \sum_{k=1}^{3} \delta_k I_{it}^k + \mathbf{x}_{jt}\delta_{Control} + u_{ijmt}, \tag{6}$$

where the dependent variable $|Seat\,Share_{ijmt} - Demand\,Share_{imt}|$ is the absolute value of the difference between the seat share and demand share. Variable I_{it}^k is an indicator equal to one if the number of weeks after the release week is greater than or equal to k, so δ_k measures the change in the dependent variable from week $k-1$ to week k. Intuitively, δ_k captures the effect of the demand information revealed in the previous week on the accuracy of a seat allocation in the current week. Vector $\mathbf{x}_{jt}$ includes the time index and theater fixed effect.

Estimation results in the column (1) of Table 5 show that δ_k is negative and significant for each k, indicating that the seat shares approach the demand shares as time passes. This is what we would expect if the theaters indeed were gradually learning the demand and adjusting their seat allocations accordingly. Notably, the decrease in the deviation is the highest right after the release week, suggesting that the highest quantity of the demand information is revealed at the start of the movie run.

To see whether independent and integrated theaters learn differently, we add interactions between I_{it}^k and a dummy variable $IND\ theater_j$ that is equal to 1 for independent theaters in (6). According to the estimates in column (2) of Table 5, the accuracy of the seat allocation after the release week improves more in independent theaters. This may imply that integrated theaters have higher quality of demand information in the release week than independent theaters, and as a result, the independent theaters learn more from the demand information revealed during the first and subsequent weeks.

6 Discussion and conclusions

Our analysis suggests that integrated theaters may allocate seats more efficiently, turning away fewer consumers than independent ones. Interestingly, we observe the same pattern even when restricting attention to independent movies only. Our findings are surprising given the controversy over vertical integration and the widespread criticism towards multiplex theater chains. Indeed, the empirical studies of the movie theater industry (e.g. Fu, 2009; Hwang, 2013; Choi et al., 2015) show that integrated theaters allocate more seats and choose longer screening times for own movies. This suggests that seat allocations of integrated theaters might be distorted relative to movie demand, and thus integrated theaters potentially turn away more consumers than independent ones. Our empirical results indicate that this might not be the case.

We offer an explanation of our findings based on differences in demand information between integrated and independent theaters. We demonstrate that integrated theaters internalize the effects of acquiring demand information, and hence have stronger incentives to do it compared to independent ones. Indeed, our understanding from conversations with industry practitioners is that integrated theater chains have "program teams" responsible for seat allocations. Better demand forecasting results in a more accurate seat allocation, which in turn allows integrated theaters to turn away fewer consumers despite their bias towards own movies. We find that efficiency does not differ significantly between theaters of an independent and integrated chains, suggesting the size effect as the main source of the efficiency of seat allocation in integrated theaters. Moreover, we provide a supporting evidence of our information mechanism based on the analysis of the movie run length and the accuracy of theaters' seat allocation.

The effect of vertical integration on non-price efficiency can go far beyond theaters' seat allocations. For example, distortions introduced by integrated theaters may negatively affect production decisions of independent movie makers. Capturing these effects is an important direction for future research.

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Table 1: Distribution and Exhibition

Type	Distribution: Movies	Distribution: Audience (Millions)	Exhibition: Theaters	Exhibition: Screens
Integrated firms				
CJ	49	45	100	792
Lotte	24	18	47	410
Orion	17	24	13	133
Independent theaters				
Cinus			25	208
Others			124	453
Independent distributors				
Foreign major distributors	59	38		
Other distributors	280	30		
Total	429	155	309	1,996

Source: Kofic annual report, 2009

Table 2: Data summary

Variables	Avg.	Std. Dev.	Min.	Max.	Obs.
Seat allocation for a movie in a theater					
Weekend number of seats	959	2,330	0	58,976	781,447
Seat share (%)	3.7	8.8	0	100	781,447
Audience size of a movie in a city					
Weekday audience size	4,525	15,134	0	545,033	32,854
Demand share (%)	5.5	9.8	0	83.9	32,854
Percentage of turned away consumers					
From independent theaters	40.2	31.9	0	100	13,427
From integrated theaters	19.6	14.2	0	99.7	15,829

Table 3: COMPARING INTEGRATED AND INDEPENDENT ISOLATED THEATERS

	Radius (Kilometer)					
Regressors	1.0	1.2	1.4	1.6	1.8	2.0
VI theater	-0.249	-0.355	-0.318	-0.316	-0.354	-0.422
	(0.138)*	(0.148)**	(0.144)**	(0.147)**	(0.140)**	(0.125)***
Screens	-0.105	-0.095	-0.088	-0.087	-0.067	-0.102
	(0.036)***	(0.035)***	(0.034)**	(0.035)**	(0.031)**	(0.037)**
Time	0.001	0.001	0.001	0.001	0.001	0.001
	(0.000)***	(0.000)***	(0.000)***	(0.000)**	(0.000)**	(0.000)**
Constant	-0.993	-0.967	-1.055	-1.054	-1.232	-0.905
	(0.238)***	(0.245)***	(0.243)***	(0.250)***	(0.244)***	(0.272)***
R^2	0.167	0.175	0.146	0.143	0.128	0.153
Theaters	48	42	39	36	31	26
Observations	7,969	6,842	6,567	6,061	5,247	4,326

The table presents OLS estimates using the log of the percentage of turned away consumers $\ln Unserved_{jmt}$ as the dependent variable. Theaters defined as isolated under different radii ranging from 1 kilometer to 2 kilometers are used in the analysis, assuming that the aggregate movie demand reaches 70 percent of each theater's capacity. Standard errors (clustered by theater) are in parentheses. The notation *** indicates significance at 1%, ** at 5%, * at 10%.

Table 4: Disentangling effects of vertical integration and size

Cinus vs.	Coeff.	Std. Err.
Individual theaters	0.412	(0.086)***
Integrated chains	0.014	(0.065)

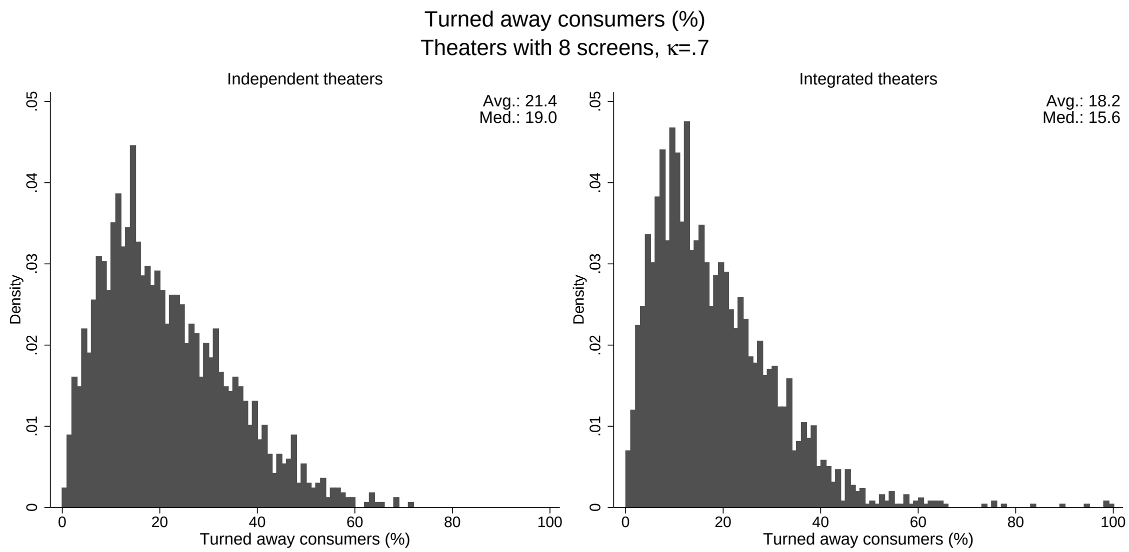
The table presents the estimates of β_{VI} in (1) comparing different group of theaters one by one with theaters of Cinus. We assume that the aggregate movie demand reaches 70 percent of each theater's capacity. Standard errors (clustered by theater) are in parentheses. The notation *** indicates significance at 1%, ** at 5%, * at 10%.

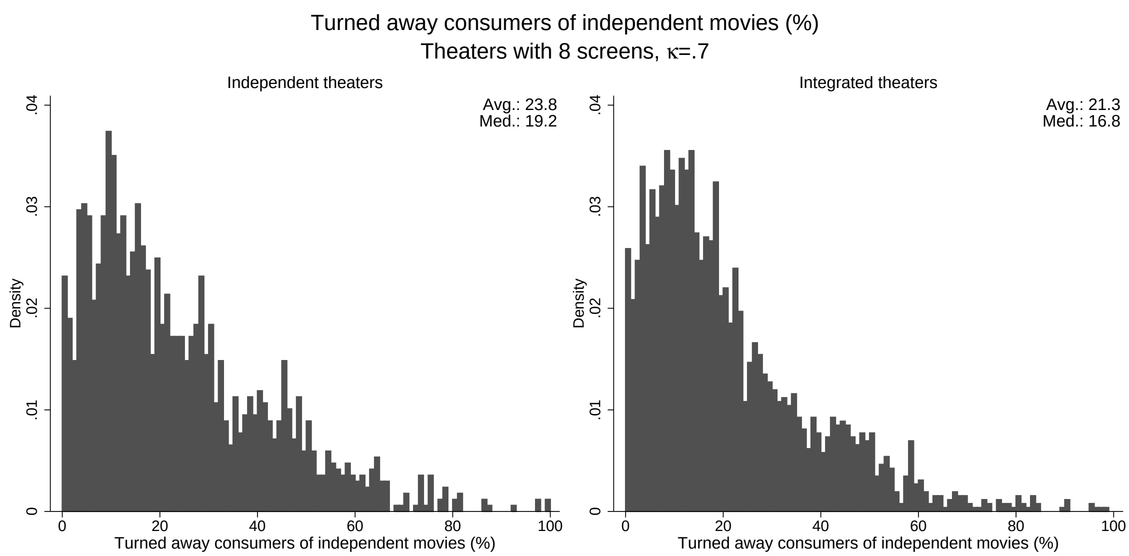
Table 5: THE EFFECT OF DEMAND INFORMATION ON SEAT ALLOCATIONS

	(1)		(2)	
Regressors	Coeff.	Std. Err.	Coeff.	Std. Err.
I^k				
$k = 1$	-0.018	(0.001)***	-0.018	(0.001)***
$k = 2$	-0.008	(0.001)***	-0.007	(0.001)***
$k = 3$	-0.010	(0.001)***	-0.009	(0.001)***
$I^k \times IND\ theater$				
$k = 1$			-0.001	(0.000)**
$k = 2$			-0.002	(0.000)***
$k = 3$			-0.002	(0.000)***
$Time$	-0.000	(0.000)***	-0.000	(0.000)***
$Constant$	0.048	(0.002)***	0.046	(0.002)***
R^2	0.113		0.113	
Observations	781,447		781,447	

The table presents OLS estimates using the absolute difference between seat share and demand share $|SeatShare_{ijmt} - DemandShare_{imt}|$ as the dependent variable. Standard errors (clustered by movie) are in parentheses. Theater fixed effect is included in the model. The notation *** indicates significance at 1%, ** at 5%, * at 10%.

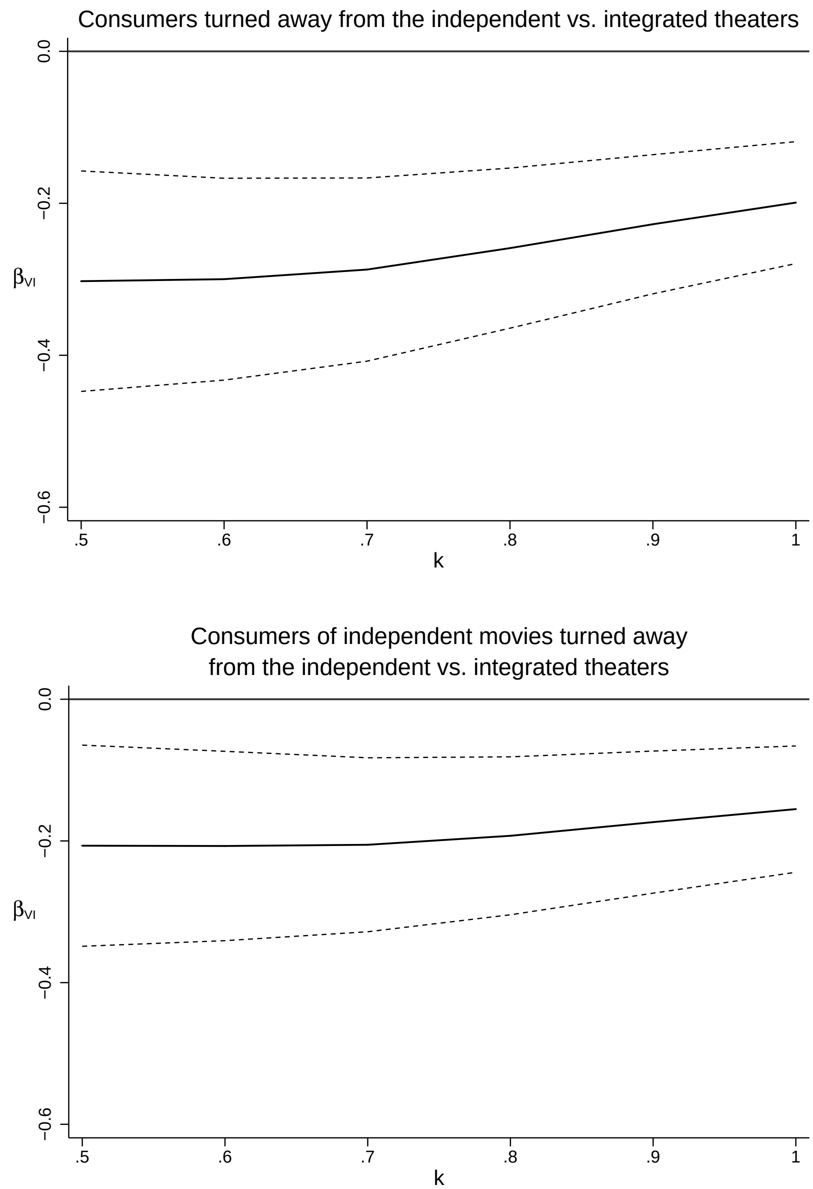
Figure 1: Distribution of percentage of turned away consumers





The figure shows the distributions of the percentage of consumers turned away from theaters with 8 screens, when the aggregate demand reaches 70 percent of each theater's seats. There are in total 1,684 observations for independent, and 2,590 observations for integrated theaters. The upper panels plot the distributions of the average percentages of turned away consumers of all movies. The lower panels plot the distributions of the average percentages of turned away consumers of independent movies only.

Figure 2: Difference in turned away consumers across theaters and movies



The top panel shows the estimated values of β_{VI} in (1) along with 95 percent confidence bands for each κ from 0.5 to 1. Similarly, the bottom panel shows the estimated values of β_{VI} using the log of the average percentage of turned away consumers among independent movie viewers ln $Unserved_{jmt}^{Ind}(\kappa)$ as the dependent variable in (1) along with 95 percent confidence bands. Standard errors are clustered by theater.

Appendix I

Because a movie demand and hence a percentage of turned away consumers varies, we simply average the percentage across theaters and weeks. However, a number of theaters also varies, and hence this approach attaches higher weights to cities and weeks with more theaters. Instead we can consider the average percentage of consumers turned away by theaters with s screens belonging to group g in city m during weekends of week t,

$$Avg.Unserved_{sgmt}(\kappa) = \frac{1}{|A_{sgmt}|} \sum_{j \in A_{sgmt}} Unserved_{jmt}(\kappa),$$

where A_{sgmt} is a set of theaters with s screens in group g, city m, and week t.

Next, for κ ranging between 0.5 and 1 we estimate

$$\ln\, Avg.Unserved_{sgmt}(\kappa) = \beta_0 + \beta_g\, g + \mathbf{x}_{st}\beta_{Control} + u_{sgmt}, \tag{7}$$

where g is equal to one for the group of integrated theaters and zero otherwise, and vector $\mathbf{x}$ includes the number of screens s and time index.

Similarly, we estimate the average percentage of turned away consumers among independent movie viewers in theaters with s screens belonging to group g in city m during weekends of week t,

$$Avg.Unserved^{Ind}_{sgmt}(\kappa) = \frac{1}{|A_{sgmt}|} \sum_{h \in A_{sgmt}} Unserved^{Ind}_{hmt}(\kappa)$$

and $\ln\, Avg.Unserved^{Ind}_{sgmt}(\kappa)$ as a dependent variable in (7).

The results are summarized graphically in Figure A3 that shows the estimated values of β_g, along with 95 percent confidence bands for each κ. Consistent with previous results in Figure 2, the estimates are always negative and statistically significant. For example, given the same number of screens and assuming that demand reaches 70 percent of each theater's capacity, integrated theaters would turn away roughly 34 percent fewer consumers than independent ones.

Appendix II

Proof of Proposition 1. The theater solves

$$\max_{s_1,s_2\geq 0}\sum_{j=1,2}\delta_j\left[\int_0^{s_j} q_j dP^\eta(q_j|\hat{q}_j)+s_j\int_{s_j}^{\infty} dP^\eta(q_j|\hat{q}_j)\right]$$

subject to $s_1+s_2=1$. Clearly, the second order condition holds. From the first order condition (4) using (3) we get

$$\delta_j\left[1-G^\eta\left(\frac{s_1-\hat{q}_1}{\hat{q}_1}\right)\right]=\delta_i\left[1-G^\eta\left(\frac{1-s_1-\hat{q}_2}{\hat{q}_2}\right)\right].$$

If $\delta_j=\delta_i=\lambda$, then $s_j=\frac{\hat{q}_j}{\hat{q}_j+\hat{q}_i}$ for $j=1,2$. If $\delta_j=1$ and $\delta_i=\lambda$, then the result follows from LHS being decreasing and RHS increasing in s_1. □

Before we provide the proof of Proposition 2 we need to introduce the following definition and lemma that can also be found in Persico (2000).

Definition. A function $H(v)$ is *quasi-monotone* if $v'>v$ and $H(v)>0$ imply $H(v')\geq 0$.

Lemma. *Let (c,d) be an interval of the real line, $J(\cdot)$ a nondecreasing function, $H(\cdot)$ a quasi-monotone function. Assume that for some measure μ on $\mathbb{R}$ we have $\int_c^d H(v)d\mu(v)=0$. Then $\int_c^d H(v)J(v)d\mu\geq 0$.*

Proof of Proposition 2. We shall show that the marginal value of information is higher for integrated theaters. Denote the type of a theater, independent or integrated, by subscript $\tau\in\{Ind,Int\}$. For each τ let $s_\tau^{\eta,\hat{q}_1,\hat{q}_2}$ be the optimal allocation for movie 1, and $\pi^\tau(s_\tau^{\eta,\hat{q}_1,\hat{q}_2},q_1,q_2)$ the maximal profit given accuracy η, signals $\hat{q}_1$ and $\hat{q}_2$, and movie demands q_1 and q_2. Define

$$u(\eta,\hat{q}_1,\hat{q}_2,q_1,q_2):=\pi^{Int}(s_{Int}^{\eta,\hat{q}_1,\hat{q}_2},q_1,q_2)-\pi^{Ind}(s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2},q_1,q_2).$$

We want to show that

$$\frac{d}{d\theta}\iiiint_{\mathbb{R}_+} u(\theta,\hat{q}_1,\hat{q}_2,q_1,q_2)dF^{\theta}(\hat{q}_1|q_1)dF^{\theta}(\hat{q}_2|q_2)dP(q_1)dP(q_2)\Big|_{\theta=\eta} \geq 0. \tag{8}$$

Note that from (2) it follows that $T_{\eta,\theta,q}(\hat{Q}^{\eta}_j|q_j)$ is distributed as $\hat{Q}^{\theta}_j$. Hence applying the change of variable in (8) we have

$$\begin{aligned}&\iiiint_{\mathbb{R}_+} \frac{du(\theta,T_{\eta,\theta,q_1}(\hat{q}_1),T_{\eta,\theta,q_2}(\hat{q}_2),q_1,q_2)}{d\theta}\Big|_{\theta=\eta} dF^{\eta}(\hat{q}_1|q_1)dF^{\eta}(\hat{q}_2|q_2)dP(q_1)dP(q_2)\\ &\quad=\iiiint_{\mathbb{R}_+} \frac{du(\theta,T_{\eta,\theta,q_1}(\hat{q}_1),T_{\eta,\theta,q_2}(\hat{q}_2),q_1,q_2)}{d\theta}\Big|_{\theta=\eta} dP^{\eta}(q_1|\hat{q}_1)dP^{\eta}(q_2|\hat{q}_2)dF^{\eta}(\hat{q}_1)dF^{\eta}(\hat{q}_2).\end{aligned}$$

We now show that the inner double integral above is nonnegative. Evaluating it we get:

$$\begin{aligned}&\iint_{\mathbb{R}_+} \frac{\partial\pi^{Int}(s^{\eta,\hat{q}_1,\hat{q}_2}_{Int},q_1,q_2)}{\partial s_{Int}}\left[\frac{\partial s^{\theta,\hat{q}_1,\hat{q}_2}_{Int}}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Int}}{\partial\hat{q}_1}\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Int}}{\partial\hat{q}_2}\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial\theta}\Big|_{\theta=\eta}\right]\\ &-\frac{\partial\pi^{Ind}(s^{\eta,\hat{q}_1,\hat{q}_2}_{Ind},q_1,q_2)}{\partial s_{Ind}}\left[\frac{\partial s^{\theta,\hat{q}_1,\hat{q}_2}_{Ind}}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Ind}}{\partial\hat{q}_1}\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Ind}}{\partial\hat{q}_2}\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial\theta}\Big|_{\theta=\eta}\right]\\ &\qquad\times dP^{\eta}(q_1|\hat{q}_1)dP^{\eta}(q_2|\hat{q}_2).\end{aligned} \tag{9}$$

For each τ we have $\frac{\partial s^{\theta,\hat{q}_1,\hat{q}_2}_{\tau}}{\partial\theta}\Big|_{\theta=\eta}$ is independent of q_1 and q_2, and

$$\iint_{\mathbb{R}_+} \frac{\partial\pi^{\tau}(s^{\eta,\hat{q}_1,\hat{q}_2}_{\tau},q_1,q_2)}{\partial s_{\tau}}dP^{\eta}(q_1|\hat{q}_1)dP^{\eta}(q_2|\hat{q}_2) = 0$$

by the first order condition. So, we can rewrite (9) as

$$\begin{aligned}&\iint_{\mathbb{R}_+} \frac{\partial\pi^{Int}(s^{\eta,\hat{q}_1,\hat{q}_2}_{Int},q_1,q_2)}{\partial s_{Int}}\left[\frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Int}}{\partial\hat{q}_1}\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Int}}{\partial\hat{q}_2}\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial\theta}\Big|_{\theta=\eta}\right]dP^{\eta}(q_1|\hat{q}_1)dP^{\eta}(q_2|\hat{q}_2)\\ -&\iint_{\mathbb{R}_+} \frac{\partial\pi^{Ind}(s^{\eta,\hat{q}_1,\hat{q}_2}_{Ind},q_1,q_2)}{\partial s_{Ind}}\left[\frac{\partial s^{\eta,\hat{q}_1,\hat{q}_2}_{Ind}}{\partial\hat{q}_1}\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial\theta}\Big|_{\theta=\eta} + \frac{\partial s^{\theta,\hat{q}_1,\hat{q}_2}_{Ind}}{\partial\hat{q}_2}\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial\theta}\Big|_{\theta=\eta}\right]dP^{\eta}(q_1|\hat{q}_1)dP^{\eta}(q_2|\hat{q}_2).\end{aligned}$$

Rearranging we get

$$\iint_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_1} \left.\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial \theta}\right|_{\theta=\eta} + \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_2} \left.\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial \theta}\right|_{\theta=\eta} dP^\eta(q_1|\hat{q}_1) dP^\eta(q_2|\hat{q}_2).$$

Integrating out q_2 in the first term and q_1 in the second term we have

$$\int_{\mathbb{R}_+} \left[\int_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_1} dP^\eta(q_2|\hat{q}_2)\right] \left.\frac{\partial T_{\eta,\theta,q_1}(\hat{q}_1)}{\partial \theta}\right|_{\theta=\eta} dP^\eta(q_1|\hat{q}_1)$$
$$+ \int_{\mathbb{R}_+} \left[\int_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_2} dP^\eta(q_1|\hat{q}_1)\right] \left.\frac{\partial T_{\eta,\theta,q_2}(\hat{q}_2)}{\partial \theta}\right|_{\theta=\eta} dP^\eta(q_2|\hat{q}_2).$$

Now we use the Lemma to show that the two terms above are nonnegative. First, note that

$$\begin{aligned} \frac{\partial T_{\eta,\theta,q_j}(\hat{q}_j)}{\partial \theta} &= \lim_{\theta \downarrow \eta} \frac{T_{\eta,\theta,q_j}(\hat{q}_j) - T_{\eta,\eta,q_j}(\hat{q}_j)}{\theta - \eta} \\ &= \lim_{\theta \downarrow \eta} \frac{T_{\eta,\theta,q_j}(\hat{q}_j) - \hat{q}_j}{\theta - \eta} \end{aligned}$$

is increasing in q_j because $T_{\eta,\theta,q_j}(\hat{q}_j)$ is increasing by assumption. By the first order conditions

$$\iint_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_j} dP^\eta(q_1|\hat{q}_1) dP^\eta(q_2|\hat{q}_2) = 0 \tag{10}$$

for each j. So, to apply the Lemma it remains to show that

$$\int_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_1} dP^\eta(q_2|\hat{q}_2) \tag{11}$$

is quasi-monotone in q_1, and

$$\int_{\mathbb{R}_+} \frac{\partial u(\eta, \hat{q}_1, \hat{q}_2, q_1, q_2)}{\partial \hat{q}_2} dP^\eta(q_1|\hat{q}_1) \tag{12}$$

is quasi-monotone in q_2. Using the definition of payoff rewrite (11) as:

$$\int_{\mathbb{R}_+} \left[\frac{\partial \min\left\{q_1, s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Int}} + \lambda \frac{\partial \min\left\{q_2, 1 - s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Int}} \right] \frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} - \lambda \left[\frac{\partial \min\left\{q_1, s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Ind}} + \frac{\partial \min\left\{q_2, 1 - s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Ind}} \right] \frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} dP^\eta(q_2|\hat{q}_2).$$

Integrating the above we get

$$\frac{\partial \min\left\{q_1, s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Int}} \frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} - \lambda \frac{\partial \min\left\{q_1, s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}\right\}}{\partial s_{Ind}} \frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} + \lambda \left[\frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} \left[1 - P^\eta(1 - s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2)\right] - \frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} \left[1 - P^\eta(1 - s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2)\right] \right].$$

From Proposition 1 we know that $s_{Int}^{\eta,\hat{q}_1,\hat{q}_2} > s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}$, hence if

$$\frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} \left[1 - P^\eta(1 - s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2)\right] - \frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} \left[1 - P^\eta(1 - s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2)\right] < 0, \tag{13}$$

then (11) is negative for $q_1 \leq s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}$, and positive for $q_1 > s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}$, and hence is quasi-monotone in q_1. So, it remains to show (13). Because $s_{Int}^{\eta,\hat{q}_1,\hat{q}_2} > s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}$, we get

$$1 - P^\eta(1 - s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2) < 1 - P^\eta(1 - s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}|\hat{q}_2).$$

Therefore it is sufficient to prove that $\frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} < \frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1}$. Implicitly differentiating the first order conditions and using (3) we obtain

$$\frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} = \frac{s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\hat{q}_1} \frac{\frac{1}{\hat{q}_1} g^\eta(z_1^{Ind})}{\frac{1}{\hat{q}_1} g^\eta(z_1^{Ind}) + \frac{1}{\hat{q}_2} g^\eta(z_2^{Ind})} = \frac{s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\hat{q}_1} \frac{\frac{1}{\hat{q}_1} h^\eta(z_1^{Ind})}{\frac{1}{\hat{q}_1} h^\eta(z_1^{Ind}) + \frac{1}{\hat{q}_2} h^\eta(z_2^{Ind})},$$

and

$$\frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1} = \frac{s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\hat{q}_1} \frac{\frac{1}{\hat{q}_1} g^\eta(z_1^{Int})}{\frac{1}{\hat{q}_1} g^\eta(z_1^{Int}) + \lambda \frac{1}{\hat{q}_2} g^\eta(z_2^{Int})} = \frac{s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\hat{q}_1} \frac{\frac{1}{\hat{q}_1} h^\eta(z_1^{Int})}{\frac{1}{\hat{q}_1} h^\eta(z_1^{Int}) + \frac{1}{\hat{q}_2} h^\eta(z_2^{Int})},$$

where $z_1^\tau = \frac{s_\tau^{\eta,\hat{q}_1,\hat{q}_2} - \hat{q}_1}{\hat{q}_1}$ and $z_2^\tau = \frac{1 - s_\tau^{\eta,\hat{q}_1,\hat{q}_2} - \hat{q}_1}{\hat{q}_1}$, and $h^\eta(x) = \frac{g^\eta(x)}{1 - G^\eta(x)}$ is the hazard function of

$G^\eta(x)$. Finally, we get

$$\begin{aligned}\frac{\frac{\partial s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1}}{\frac{\partial s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}}{\partial \hat{q}_1}} &= \frac{s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}}{s_{Int}^{\eta,\hat{q}_1,\hat{q}_2}} \frac{1+\frac{\hat{q}_1}{\hat{q}_2}\frac{h^\eta(z_2^{Int})}{h^\eta(z_1^{Int})}}{1+\frac{\hat{q}_1}{\hat{q}_2}\frac{h^\eta(z_2^{Ind})}{h^\eta(z_1^{Ind})}} \\ &< 1,\end{aligned}$$

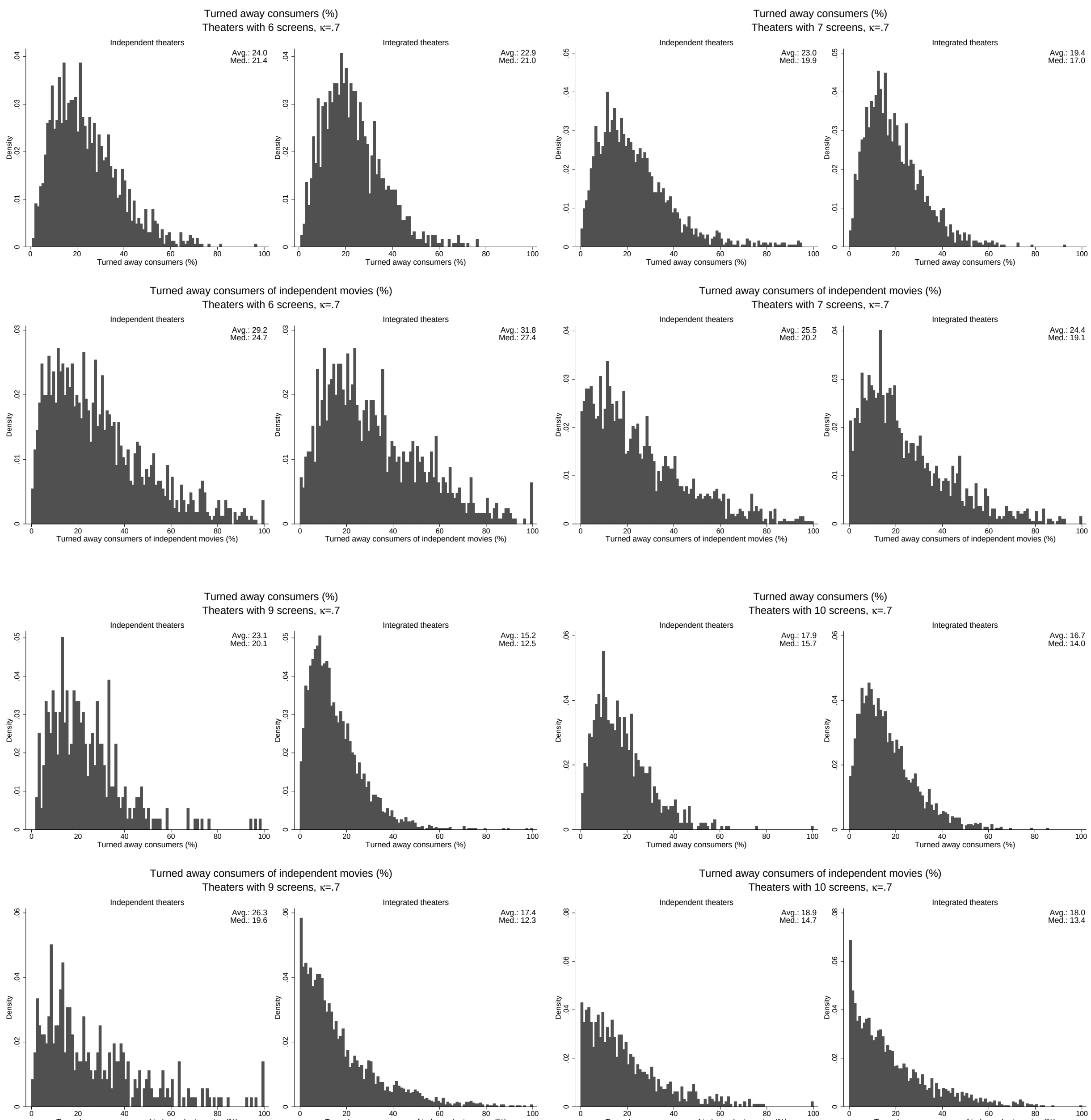
where the inequality is due to $s_{Int}^{\eta,\hat{q}_1,\hat{q}_2} > s_{Ind}^{\eta,\hat{q}_1,\hat{q}_2}$ by Proposition 1, $z_2^{Ind} = z_1^{Ind}$ and $z_2^{Int} < z_1^{Int}$ from the first order condition, and $h^\eta(\cdot)$ is increasing by log-concavity of $g^\eta(x)$. Therefore (13) holds, and (10) is quasi-monotone. The proof that (12) is quasi-monotone in q_2 follows the similar steps using the fact that $\frac{s_\tau^{\eta,\hat{q}_1,\hat{q}_2}}{\hat{q}_2} < 0$. Hence, the marginal value of information is higher for integrated theaters and the standard comparative statics argument yields the result. □

Table A1: TURNED AWAY CONSUMERS

	All Movies		Independent Movies	
Regressors	Coeff.	Std. Err.	Coeff.	Std. Err.
VI *theater*	-0.287	(0.061)***	-0.205	(0.062)***
Screens	-0.162	(0.014)***	-0.190	(0.014)***
Time	0.001	(0.000)***	0.002	(0.000)***
Constant	-0.519	(0.103)***	-0.438	(0.102)***
R^2	0.358		0.292	
Observations	29,240		29,026	

The table presents OLS estimates using the log of the percentage of turned away consumers $\ln Unserved_{jmt}$ and the log of the percentage of turned away consumers of independent movies $\ln Unserved_{jmt}^{Ind}$ as the dependent variable one by one. We assume that the aggregate movie demand reaches 70 percent of each theater's capacity. Standard errors (clustered by theater) are in parentheses. The notation *** indicates significance at 1%, ** at 5%, * at 10%.

Figure A1: Distribution of percentage of consumers turned away from theaters of different sizes



The figure shows the distributions of the percentage of consumers turned away from theaters with 6, 7, 9 and 10 screens respectively, when the aggregate demand reaches 70 percent of each theater's seats. The first and third panels plot the distributions of the average percentages of turned away consumers of all movies. The second and fourth panels plot the distributions of the average percentages of turned away consumers of independent movies only.

Figure A2: Distribution of theaters by the number of screens

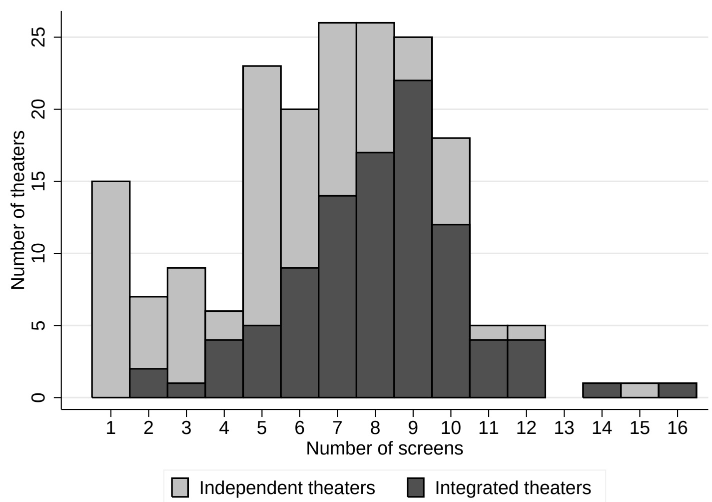
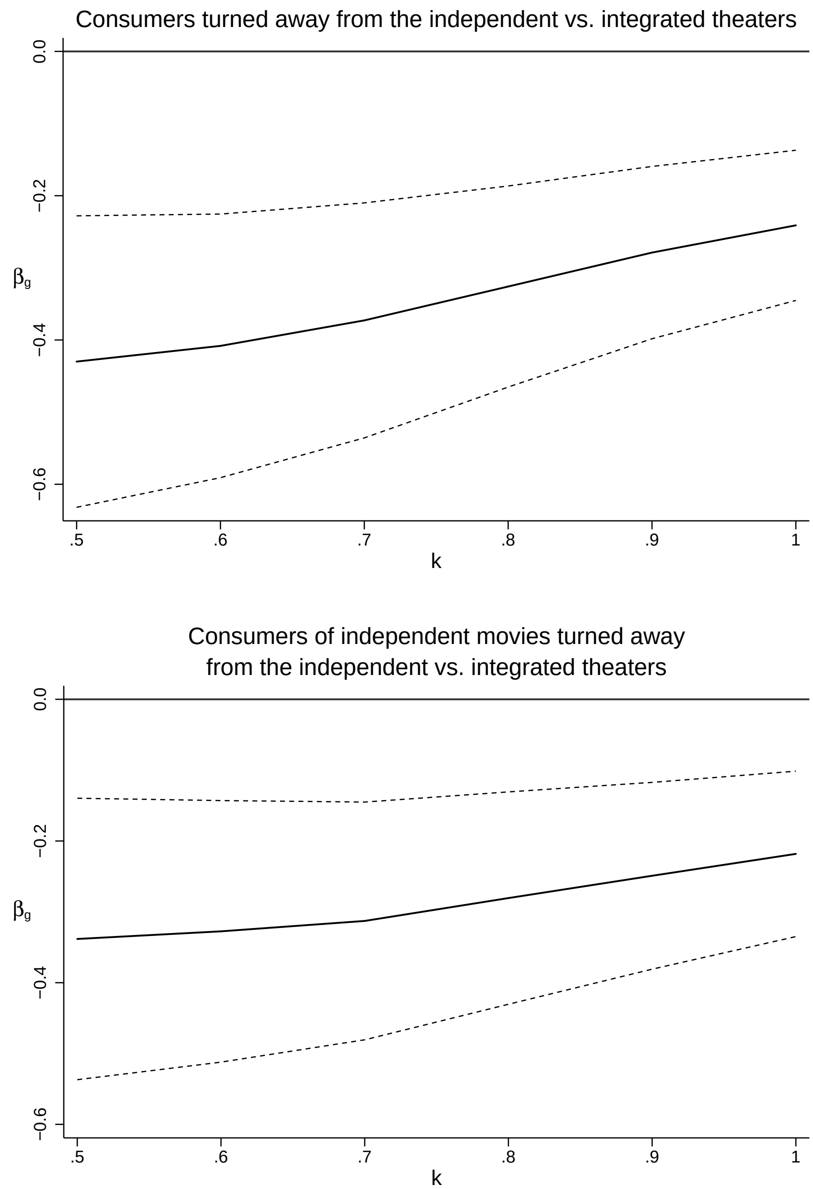


Figure A3: Robustness: Difference in turned away consumers across theaters and movies



The top panel shows the estimated values of β_g in (7) along with 95 percent confidence bands for each κ from 0.5 to 1. Similarly, the bottom panel shows the estimated values of β_g using the log of the average percentage of turned away consumers among independent movie viewers $\ln Avg.Unserved^{Ind}_{sgmt}(\kappa)$ as the dependent variable in (7) along with 95 percent confidence bands. Standard errors are clustered by theater group.