Markups and Costs under Capacity Constraints: the Welfare Effects of Hotel Mergers

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Abstract

Hotel chain mergers increase market concentration but also stand to decrease average costs, leading to ambiguous consumer welfare effects. This paper constructs an equilibrium model of the U.S. hospitality sector, incorporating a flexible model of costs which captures capacity constraints and firm size. I show that firms with larger hotel portfolios face lower average costs when approaching full occupancy. In counterfactual analysis, I find that merging firms decrease average costs (-2.19%) but raise prices (1.34%): however, pro-competitive merger outcomes are obtainable in markets where hotel chains are not overly large and are able to reduce costs through pooling unused capacity.

Keywords: Lodging Industry, Mergers, Economies of scale, Antitrust

JEL Codes: L11; L13; L22; Z31

1 Introduction

A fundamental problem facing regulatory authorities is how to evaluate proposed mergers, which is more complicated in environments where there are potential economies of scale which lead to ambiguous consumer welfare effects (Williamson (1968)). Regulators in the US have long accepted the potential of efficiencies—particularly merger-specific efficiencies—as a defense against antitrust concerns.[1] An area where these defenses are often made is in capacity-constrained industries, where mergers can reduce marginal costs through acquiring underutilized capacity or pooling capacity against volatile demand.[2] The hotel sector is one such example of an industry where market power and efficiencies interact: a trend of consolidation has led to large, global chains, which raises concerns about market power, but there is also potential for supply-side efficiencies as firms with multiple locations in a market may be able to more efficiently manage their hotels' capacity utilization ("revenue management").

This paper aims to provide evidence on the quantitative importance of scale economies in the US hotel industry, and assess whether they are large enough to offset consumer welfare losses resulting from merged firms' increased market power. I estimate a model of competition with capacity constraints—in which joint ownership creates efficiencies—in order to study mergers and other changes in the sizes (i.e. the number and capacity of owned hotels) of firms in the US hotel sector, and address two questions. First, I measure the efficiencies achieved by increasing the number of rooms and properties held by a given hotel firm, and compare them to the magnitudes of the estimated markups for different firm sizes. Second, I quantify the net welfare effects—on consumers and on the full market—of mergers and examine how market conditions affect the results in order to provide guidance for antitrust policy. I examine two classes of mergers with policy relevance: a simulated large merger scenario where Marriott International did not acquire Starwood Hotels & Resorts in 2016, and a set of sequential small acquisitions by large chain firms which might be overlooked by competition authorities.[3]

Costs and consumer welfare are not directly observable in the available data. To identify these values, I construct an equilibrium model of nightly supply and demand in the hotel sector. I estimate a firm-level cost function which allow for variation across occupancy rates and firm size, and determine the impact of capacity constraints on marginal costs and the degree to which firm

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[1] U.S. Department of Justice and Federal Trade Commission (2023), henceforth 2023 Merger Guidelines.

[2] See e.g. U.S. v. Carillon Health System, a merger among hospitals that made reference to both administrative efficiencies and fuller utilization of available beds (Eisenstadt (1999)), and the Sprint/T-Mobile merger, where efficiencies were related to reducing network marginal costs related to congestion of network capacity (Asker and Katz (2023)).

[3] The under-enforcement of smaller mergers that drive consolidation has been discussed in work such as Wollman (2021) in the healthcare sector.

size affects said impact. In merger analysis, I then determine the magnitudes of the offsetting markup and cost effects, and calculate changes in consumer welfare. Hotel firms, which I define as the parent company (e.g. Marriott International, Hilton Hotels & Resorts, etc.), own and operate hotels across metropolitan statistical areas (MSAs) and market segments; this paper examines mergers within the same market. These market segments are categories comprised of the chain scale of hotels (an industry measure of quality, such as Upscale or Luxury) and their location (e.g. whether the segment is downtown, or near an airport). A merger of hotel firms hence affects the share of properties and rooms the combined firm operates, both within and across segments in an MSA.

I estimate the model with data from STR LLC, who provide nightly hotel-level prices—average daily rate (ADR)—and the quantities of rooms sold and available for 1,561 hotels in 15 MSAs from 5 different states, from 2014 to 2018. Individual hotels are identified but are anonymous. Observed prices are the average rate paid by all guests staying on a given night. STR also provides pseudonymous firm-ownership data at the monthly level, allowing for changes in parent company ownership to be tracked without identifying the individual hotels. Daily-level observations provide extensive variation in observed demand: occupancy varies between 0.18% and 100%, with a mean of 64%, and 5.4% of hotel-nights are above 99% occupancy (3.6% at 100% occupancy). Variation in firm size and hotel ownership over periods of different occupancy rates provides identifying variation for the parameters of the cost function.

Using these data, I estimate a nested logit model of consumer demand, where consumers choose among the set of market segments nested by location category. On the supply side I employ a model of Cournot competition among hotel firms, where firms choose nightly segment-level quantities in each segment where they operate hotels. The key feature is that the firm faces a within-segment soft capacity constraint: the marginal cost curve is constant up to an occupancy rate threshold, above which it is convex and increasing. I estimate the firm's occupancy rate threshold as a function of firm size (the number and capacity of owned hotels in the segment), flexibly allowing size variation to drive variation in the nonlinear marginal costs at high occupancy rates. This approach has two advantages. The first is that—unlike a more literal vertical hard constraint—the cost curve is continuous and differentiable at all points, which provides tractability in solving for counterfactual equilibria. Second, the literature on hotel pricing has already noted that the hotel's response to capacity limitations does not begin at the hard constraint, but rather intensifies as it approaches it (Cho, Lee, Rust, and Yu (2018)). The soft constraint approach has been applied in several other settings: Ryan (2012) and Fowlie, Reguant, and Ryan (2016) estimate this constraint in the cement sector, and Farronato and Fradkin (2022) calibrates a similar model for hotels.[4]

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[4]In Section 2.2, I discuss this modeling approach in the context of hotel revenue management, and the intuition behind this channel of efficiency.

The results show two patterns of cost variation across hotel-nights. Firms face higher marginal room costs at high occupancy rates as the opportunity cost of sale rises: marginal costs for an average independent hotel are \$51 higher at 99% occupancy than at 60% occupancy. Second, I find evidence of economies of scale related to capacity utilization: firms with larger hotel portfolios in the same segment face lower marginal costs at high occupancy rates, in line with prior literature that mergers can slacken the impact of a capacity constraint (see Kalnins, Froeb, and Tschantz (2017)). A firm operating 3 hotels faces marginal costs which are \$8.30 lower at low occupancy relative to an individual hotel, and this gap widens to a reduction of \$17.62 at full occupancy. These results vary by market segment: airport hotels face the least-tight constraints, while downtown hotels respond earliest to capacity constraints. Holding quantities constant, increased markups outweigh reductions in cost for mergers involving more than a small number of homogeneous properties.

Finally, I assess the market conditions where mergers can have pro-competitive outcomes through a set of counterfactual merger simulations. I first use data across 8 MSAs in 2017 to simulate an environment where the 2016 Marriott-Starwood merger did not take place. This merger raised the Herfindahl-Hirschman Index (HHI) of the high-quality urban market segments by an average of 771 from an initial average of 2,467 given pre-merger quantities.[5] I find that the merger is largely harmful: despite reducing average costs by 2.2%, merging firms raised prices by 1.3% versus 0.6% for non-merging firms, and merging firms cut occupancy rates by 6.9%. The consumer welfare effects are heterogeneous within and across MSAs: over the course of 2017, consumers in Chicago lose out (−\$7.95 million) while consumers in Milwaukee, WI gain (\$0.13 million). I show that pro-competitive outcomes are more common in MSAs where i) industry concentration is lower, ii) firms are at high capacity utilization and face high costs, and iii) the merging firms are uncorrelated in capacity utilization such that they can jointly employ capacity at lower cost.

Second, I construct a series of 13 single-property acquisitions in the high-quality urban Chicago market, undertaken by two firms which vary in initial market share (17.7% of sales versus 29.4% of sales), and examine marginal and total effects. The former sequence reduces costs and prices in 11 of 13 mergers, resulting in consumer welfare gains even when the cumulative change in HHI is well over the structural presumption in the 2023 Merger Guidelines. The latter case, which begins near the market share threshold in the Guidelines, raises prices and reduces consumer welfare in all 13 mergers, as cost reductions are minimal relative to the effects of the firm's increased market power.

These findings provide evidence that cognizable efficiencies are obtainable—but not guaranteed—in capacity-constrained industries.[6] The counterfactual analysis shows that most large mergers and

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[5]High-quality refers to upscale, upper upscale, and luxury hotels. This merger was ultimately not challenged by regulatory authorities owing to the presence of sufficient competition in the high-quality hotel space. Statements by the firms and regulatory authorities are discussed in Section 2.3.

[6]Cognizable efficiencies are merger-specific, verifiable, prevent a reduction in competition, and are not anti-

acquisitions harm consumer welfare, in line with structural presumptions and skepticism towards efficiencies in the 2023 Merger Guidelines. However, mergers reduce prices when hotel chains are not overly large relative to the market, and where large rivals can pool capacity effectively or where firms acquire higher-cost small rivals, leading to localized consumer welfare gains during periods when demand is highest. The results reinforce the importance of analyzing efficiencies in the context of potential market power, particularly given continued consolidation in the hotel sector.

This paper contributes to the literature in three main areas. First, there is an extensive body of literature on merger efficiencies and their relation to antitrust enforcement. Numerous researchers (Whinston (2007), Carlton (2009), Ashenfelter, Hosken, and Weinberg (2013)) have noted the need for more data on merger outcomes to guide antitrust decisions and reform: this paper adds evidence in the novel case of mergers of capacity-constrained firms where efficiencies may offset market power increases. Bhattacharya, Illanes, and Stillerman (2023) examine a panel of mergers to assess their effects, noting that in many cases—potentially those engaging in dynamic pricing or with overlapping distribution networks—mergers have price-reducing effects. Furthermore, considering merger-specific efficiencies—and hence the trade-offs inherent in market concentration—relates to the question of whether antitrust enforcement has been overly lax. A body of literature examines agency decisions (Kwoka (2014), Scott Morton (2019), Shapiro (2021), Nocke and Whinston (2022), Rose and Shapiro (2022)). Wollman (2021) considers the case of sequences of small mergers which add up to larger consolidations in the healthcare industry: a similar pattern of small acquisitions is occurring in the hotel industry.

Second, this paper adds to studies of oligopolistic competition under capacity constraints, and how these constraints can be modeled and estimated. As previously mentioned, the use of convex marginal cost curves to reflect capacity-constrained behavior has been shown in Besanko and Doraszelski (2004), Ryan (2012), Fowlie et al. (2016), and Farronato and Fradkin (2022). These approaches provide tractability in approaching counterfactuals where data- and computation-intensive approaches to unobserved choice sets such as Conlon and Mortimer (2013) or Agarwal and Somaini (2022), or explicit dynamic modeling such as Cho et al. (2018), who model a single hotel's revenue management problem, or the approaches by Gedge, Roberts, and Sweeting (2020) and Williams (2022) with airlines, would be infeasible. This paper exploits the clearly observable capacity constraints present in the hotel industry, and incorporates these constraints—and hence an approximation to the outcomes of the dynamic models—into an equilibrium model that assesses a market-level counterfactual.

Finally, I add to a growing body of work on the hotel sector relating to its operation and regulation. Kosová, Lafontaine, and Perrigot (2013) and Hollenbeck (2017) discuss the ramifications of

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competitive for rivals. U.S. Department of Justice and Federal Trade Commission (2023) Section 3.3.

hotel organizing via chain and franchise structures. Mazzeo (2002), Lewis and Zervas (2019), and Armona, Lewis, and Zervas (2021) provide examples of measuring supply and demand for hotel rooms. Farronato and Fradkin (2022) takes an aggregated approach to explore the effects of Airbnb, showing that flexible peer supply absorbs demand volatility. Kalnins et al. (2017) have previously shown with reduced-form evidence that mergers can increase occupancy. This paper quantifies the economies of scale and cost efficiencies in order to explore their ramifications in policy experiments.

In Section 2, I discuss relevant institutional details of the hotel industry. Section 3 discusses the available data and explores descriptive patterns related to the identification of the model. In Section 4, I outline the design and estimation of the structural model, and present the results in Section 5. Section 6 constructs the counterfactual scenarios and estimates the quantity and welfare effects using the model parameters. I conclude with a discussion in section 7.

2 Industry and Policy Background

In this section, I summarize (i) the outline of the hotel industry, (ii) how revenue management results in potential efficiencies in nonlinear costs, and (iii) relevant policy and responses to large mergers.

2.1 Industry Background

Over the past 30 years, consolidation in the hotel sector has intensified as large, global chains both acquire brands and develop them internally. Much of this consolidation has taken place through large, high-profile mergers: in 2005, the Hilton Hotel Corporation acquired Hilton International for $5.8 billion, and in 2015, Marriott International announced its intent to acquire Starwood Hotels & Resorts Worldwide in a deal valued at $13.6 billion.[7] More recently, in 2022 Choice Hotels acquired Radisson, and in 2023 it made a move to acquire Wyndham for approximately $7.8 billion.[8] Table 1 summarizes other recent mergers of firms from 2014 to 2018 in the hospitality industry.[9] Many other mergers, however, involve one of the global chains (or even a smaller regional chain) acquiring a brand line or set of independent hotels. These consolidations are not commonly subjected to regulatory oversight owing to their comparative small size in regional or national markets.

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[7]This deal which culminated on September 23, 2016, created the largest hotel company in the world with over 5,700 properties and 1.1 million rooms (Dogru, Erdogan, and Kizildag (2018)).

[8]Choice's offer for Wyndham on October 17, 2023 was ultimately rejected by shareholders, as were subsequent takeover bids.

[9]Appendix Table 1, reproduced from Slattery and Gamse (2016) and Roper (2018), lists historical brand acquisitions from 2005-2015.

Table 1: Sample Mergers in the US Hospitality Sector

Acquiring Company	Acquired Company	Year	Deal Value
InterContinental Hotels Group	Kimpton Hotels + Restaurants	2014.12	$430 million
Wyndham Hotel Group	Dolce Hotels & Resorts	2015.02	$57 million
Red Lion Hotels Corporation	GuestHouse International, Settle Inn & Suites	2015.04	$8.5 million
Marriott International	Starwood Hotels & Resorts Worldwide	2015.11	$13.6 billion
Red Lion Hotels Corporation	Vantage Hospitality	2016.09	$23 million
Hyatt Hotels Corp.	Miraval Group	2017.01	$215 million
Wyndham Hotel Group	AmericInn	2017.07	$170 million
Choice Hotels International	WoodSpring Suites	2017.12	$231 million
Wyndham Worldwide	La Quinta Holdings	2018.01	$1.95 billion
Red Lion Hotels Corporation	Knights Inn	2018.04	$27 million

Note: Table source is Law, Lee, Xiao, and Zhang (2020). Mergers listed take place during the 2014-2018 data period.

Hotel properties may operate independently or be affiliated with a larger brand, either through franchising or direct chain management.[10] As of 2024, there are eight major global hotel chains (parent companies): AccorHotels, Carlson Rezidor, Hyatt, Hilton, Marriott, InterContinental Hotel Group (IHG), Wyndham, and Choice. When the property is run by a franchisee, parent companies provide marketing, aid in product discovery, and also supply demand predictions, pricing guidance, and other managerial support (see Kosová et al. (2013), Hollenbeck (2017)). The largest parent companies operate multiple brand lines (e.g. Hilton and Conrad, Hilton Garden Inn, Waldorf Astoria). Hotel brands and their respective properties are organized into chain scales, an ordinal ranking of quality that groups hotel chains by their local average daily rates (ADRs). Some examples of common chains included in each scale are listed in Table 2. Independent hotels, which do not have a chain scale, can be matched to these tiers by their respective ADR relative to chain-affiliated hotels in their geographic proximity.

Table 2: Examples of Hotel Chains by Chain Scale

Chain Scale	Examples
Luxury	Four Seasons, Grand Hyatt, Park Hyatt, St. Regis, W Hotels
Upper Upscale	Autograph Collection, Embassy Suites, Hyatt, Marriott, Westin
Upscale	AC Hotels by Marriott, Allegro, Hilton Garden Inn, Wyndham
Upper Midscale	Best Western Plus, Comfort Inn, Hampton, Holiday Inn, Wyndham Garden Hotel
Midcale	Avid, Best Western, Candlewood Suites, Quality Inn, Ramada
Economy	Days Inn by Wyndham, Econo Lodge, Super 8 by Wyndham

Note: This paper will use "Class" to denote chain scale with accordingly ranked independent hotels.

The simultaneous expansion of brands and shift towards franchising represents a continued motion to compete in the brand and product spaces while also divesting brands from startup costs and the

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[10]The industry has trended towards vertical disintegration, favoring a franchise model which divests major brands of the risk of operating real estate in favor of consistent revenue through fees and lower costs of expansion. See Roper (2018).

risks of property ownership (Roper (2018)). This paper does not focus on the strategic aspect of competition through endogenous product placement, or the decision-making involved in franchising.[11] Instead, this paper focuses on the static impact of chain size within a given market on costs, providing evidence for the validity of efficiencies as a merger defense when the market structure is otherwise held constant.

2.2 Revenue Management and Efficiency

The hotel sector, like other industries with constrained supply (airlines, car rentals, etc.) widely utilizes revenue management systems to ration capacity.[12] The use of these algorithmic pricing tools results in a data-generating process that is difficult to model. These tools are black boxes, which vary across hotels in objective, implementation, and the data available to target their outcomes. The common assumption observing an equilibrium in the data may in cases be overly strong as agents have unknown information, assumptions, and objective functions. The operations literature has explored theory and applications of revenue management systems (Kimes (1989) and McGill and Van Ryzin (1999) provide discussion from airlines and transportation), while in economics attempts to recover or approximate algorithmic pricing outcomes have been made, using dynamic models (Cho et al. (2018), Gedge et al. (2020), and Williams (2022)) and agent-based approaches (see Aguirregabiria and Jeon (2020) and Aguirregabiria and Magesan (2020)).

In order to reflect these dynamics while allowing for the computation of counterfactual market equilibria, I take a static approach to modeling capacity constraints via the firm's cost function. Cho et al. (2018), in modeling the dynamic problem, find that an approximation of the dynamic pricing heuristic is for firms to unilaterally deviate from competitive pricing when the risk of stockout reaches some threshold, in order to ration its remaining rooms. This can be interpreted as if the firm continued to price competitively while facing a marginal cost curve which increases steeply after this threshold in occupancy, reflecting the rising option value of open capacity. In aggregate, the outcomes of this unconstrained model approximate the dynamic model, and capture the effect of capacity constraints—through revenue management—on market outcomes.[13]

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[11]Kosová et al. (2013) show that firms decide whether to franchise or chain-manage properties based on profitability such that the marginal property is indifferent between management options. With the exception of Hyatt, which has been slower to divest its properties than its competitors, most major chains are almost entirely operated as franchises. See Roper (2018), Chapter 9.

[12]The introduction of Cho et al. (2018) provides a thorough summary of the hotel industry landscape with respect to these tools. Kimes (2017) summarizes the current and projected future use of revenue management in the hotel sector. See also the use of algorithmic management tools in the housing rental market (RealPage) and parking lots (e.g. https://spothero.com/sell-parking/iq).

[13]While uncommon, the process of setting prices in expectation does result in occasional overbooking: referred to as "walking", hotels can pay the added rebooking/compensation costs—as well as implicit costs to reputation—to move overbooked customers to other hotels (see: Vora (2019)). The unconstrained convex cost model reflects this.

In this context, marginal cost is in part an abstract value: a combination of the operational costs of selling a room and of rising opportunity costs owing to the option value of remaining open rooms when occupancy is higher. As discussed by Kalnins (2006) and Farronato and Fradkin (2022), the firm's marginal costs in the model should not be taken as the actual expenditures per night for the firm. Firms set prices based on a number of considerations that factor into their perceived costs, such as the amortization of fixed or contracted long-term costs over expected room sales, or expected added revenue and costs through non-room amenities. Additionally, hotels may enforce a minimum price threshold due to reputational concerns which exceeds the marginal cost of selling a room. I treat recovered costs simply as the minimum price threshold under which hotels would be unwilling to sell a room at all. This also suggests that the estimated markups are not equivalent to their accounting terms.

Given this, the efficiency channel can be described as follows. When a hotel is near its capacity constraint, the opportunity cost of selling a room is high due to its increased option value, and the firm requires sharply higher prices in order to sell its remainder of rooms. The penalty for accepting too-low prices is to reach stockout and forfeit the revenues of excess demand. When the same firm owns some proportion of the alternatives, a portion of that excess demand is recaptured.[14] The firm may, under this circumstance, be more willing to sell its final rooms at lower prices: the impact of the capacity constraint slackens, and the firm can raise quantities at the same prices, ceteris paribus.[15] As such, there is a nonlinear cost efficiency where larger firms may raise output and further reduce average costs during high-demand periods where consumers are most exposed to higher prices. Figure 1 displays this type of nonlinear cost curve, and demonstrates two types of efficiencies as shifts in the supply curve: a reduction in the linear costs of operation, which affect the cost of selling a room independent of occupancy rates (Panel A) and a reduction in the effects of the soft capacity constraint on nonlinear opportunity costs, reducing the cost of selling a room at high occupancy (Panel B).

2.3 Policy Background

Efficiencies are a commonly-cited defense for potentially anti-competitive horizontal mergers (Williamson (1968)), and regulators face a trade-off in mergers which are able to earn economies of scale yet also

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where hotels may on occasion overshoot full utilization at high cost.

[14]At the firm level, this can also be interpreted as the benefit of capacity pooling given demand diversity, where excess capacity from one property can more cheaply offset demand at another. See Asker and Katz (2023) regarding described efficiencies from Sprint/T-Mobile.

[15]A Monte Carlo test in Appendix A demonstrates this theoretical outcome given a portion of recaptured excess demand. While I do not explicitly assume or model a channel for a firm to reassign consumers to its other owned properties, hotel consumers frequently have brand preferences which drive them to search within a brand's lodging options due to familiarity, rewards networks, etc.

Figure 1: Shifts in Convex Cost Curves

(A) Shift in linear operational costs

(B) Shift in nonlinear opportunity costs
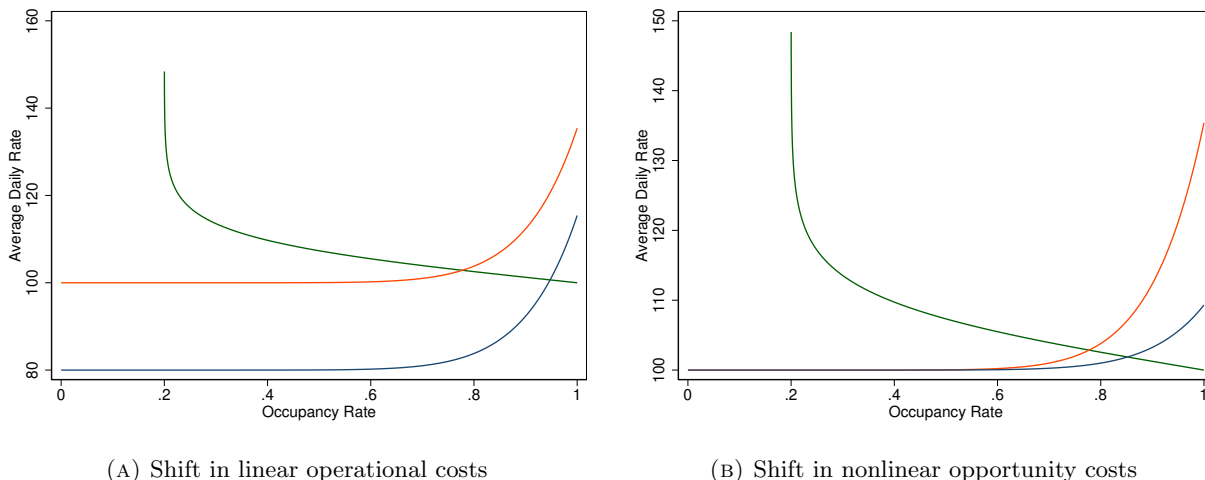
raise market power. This defense is discussed in Section 3.3 of the 2023 Merger Guidelines, which requires that procompetitive efficiencies must be cognizable: specific to the merger's consummation, verifiable by the evidence, prevent reductions in competition, and not be anticompetitive (the presence of efficiencies must therefore not empower the creation of a monopoly or worsen terms for rivals).[16] With respect to the relevance of this defense to regulators' decision-making, prior language in the 2010 Horizontal Merger Guidelines notes that "efficiencies resulting from shifting production among facilities formerly owned separately" are "more likely to be susceptible to verification."[17] Evidence for merger efficiencies is largely idiosyncratic to industries, driving the importance for industry case studies and retrospectives.

Aside from their identification, efficiencies matter because they result in nuanced merger outcomes which may or may not correspond to the Agencies' presumptive screens. The 2023 Merger Guidelines consider a presumption of illegality for mergers that significantly increase concentration in an already concentrated market: a change in HHI of at least 100, given post-merger market HHI of at least 1,800 or the merged firm's market share of at least 30%.[18] While these provide guidance for when regulators might act, outcomes for consumers ex post are more varied: Bhattacharya et al. (2023) examine a broad set of retail mergers and investigate how the presumptive screen would perform ex post, finding high variation in the actual results of mergers across HHI changes. This nuance in outcomes applies to larger trends: Section 2.7 and 2.8 of the 2023 Merger Guidelines address presumed anticompetitive effects of trends towards consolidation and sequences of small acquisitions. In each case, potential merger efficiencies make outcomes unclear, particularly as the

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[16]U.S. Department of Justice and Federal Trade Commission (2023).

[17]U.S. Department of Justice and Federal Trade Commission (2010).

[18]See Guideline 1, Section 2.1 of the 2023 Merger Guidelines.

scale economies may vary with the magnitude of acquisitions.[19]

In the context of the hotel industry, two major recent cases highlight the focus on efficiencies in proposed mergers, and the regulatory responses: Marriott's acquisition of Starwood in September 2016, and Choice's attempted acquisition of Wyndham in early 2024. In the former case, international regulators reviewed the case and ultimately approved it. Prior to the merger, Marriott highlighted potential efficiencies as a strategic merger benefit in communication with its investors, citing a prediction of $200 million in annual cost savings through operational efficiencies, as well as "realiz[ing] increased efficiency by leveraging economies of scale in areas such as reservations, procurement and shared services" (see Marriott International, Inc. (2015)). Finalized on September 23, 2016, this merger created the largest hotel company in the world, following review by global antitrust agencies which ultimately opted not to challenge the acquisition.[20] Rationale for approving the merger hinged on presumed effective competition in the 4 and 5-star segments from rivals such as Accor, Hyatt, Hilton, IHG, and independents, both in the lodging and management service areas (European Commission (2016)).

More recently, Choice's (hostile) acquisition of Wyndham—valued at approximately $7.8 billion— was investigated by the FTC, with a second request issued on January 11, 2024 before the takeover was abandoned on March 11, 2024.[21] Ultimately, the acquisition was sunk by insufficient support from shareholders rather than direct regulator intervention (Jain, Oladipo, and Sen (2024)). Rationale for the merger referenced numerous expected efficiencies, such as decreased operational expenses ($150 million), franchise costs, and dynamic efficiencies such as decreased frictions for guests by offering a broader portfolio of lodging options within a consolidated system (Choice Hotels International (2024)). Regulators focused particularly on the potential increases in market concentration within the economy and midscale sections of the market, where Choice and Wyndham were major players. This was argued to substantially lessen competition—and in turn increase costs—both for consumers (guests) and for franchisees, in contrast to Choice's statements.[22]

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[19]Wollman (2021) discusses sequential mergers in the context of U.S. dialysis, finding that firms are able to avoid regulatory attention through strategically acquiring rivals below thresholds for regulation, resulting in reduced qualities for consumers.

[20]In the US, the Federal Trade Commission allowed the waiting period for challenging the merger to run out in March 2016, choosing not to challenge the acquisition. The European Commission cleared the merger in July 2016. Chinese regulators declined to challenge the merger as of September, 2016, clearing the path to the consolidation on September 23, 2016.

[21]See Parmar (2024) related to the second request, and Federal Trade Commission (2024) for the FTC's statement on the merger's abandonment.

[22]See e.g. Warren (2024), writing to the FTC.

3 Data and Descriptive Evidence

In this section, I briefly describe the paper's data, and discuss key descriptive facts which motivate the design and identification of the structural model.

3.1 Data Source

The primary data source is STR LLC, who provide data on hotel performance. Data are provided at the level of nightly statistics for individual hotels. This panel includes the nightly average daily rates (ADR) and occupancy rates for 1,561 hotels from 2014-2018. The data cover MSAs in Indiana, Illinois, Missouri, Texas, and Wisconsin. Hotels and their parent companies in the data are identified by unique codes but are anonymous: no names, addresses, or specific identifying information is provided.

As hotels in the data cannot be matched to real-world properties, the characteristics provided for the hotels are limited. I observe the hotel's chain scale—an industry measurement for the hotel's quality tier based on their ADR—indicators for what type of location the hotel is at (airport, resort, urban, interstate, etc) and its categorical number of rooms, and the MSA the hotel is located in. Hotel parent company details are observed at the monthly level, capturing variation (cross-sectionally and over time) in firm size due to mergers and acquisitions.

3.2 Data Description

The data contain two key sources of variation over time and across markets which are central to the structural model: variation in segment prices and quantities (necessary for identifying the demand system) and variation in firm size and occupancy rates (identifies cost parameters related to economies of scale). I first describe the variation in prices and occupancy rates in the data at the segment-MSA-night level: in Section 4 I discuss the reasons for this level of aggregation. Table 3 shows the variation in prices and occupancy across market segments. Generally, the occupancy rates of higher quality hotels stochastically dominate those of lower quality hotels. More than 5% of observations are near the capacity constraint despite the segment-level aggregation, allowing for the estimation of demand and recovery of marginal costs during high occupancy periods. The modeling assumption that segments can be aggregated assumes that hotels and firms display limited variation in prices within segments. The Class-level coefficient of variation by daily MSA-segment is included in Appendix Figure 5: on average, standard deviations within market segments are approximately 0.2 of the mean. Luxury hotels see the widest variation, an intuitive observation as luxury hotels

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are the most varied in quality and have the widest variance in per room prices at a single property.

Table 3: Distribution of Prices and Occupancy Rates

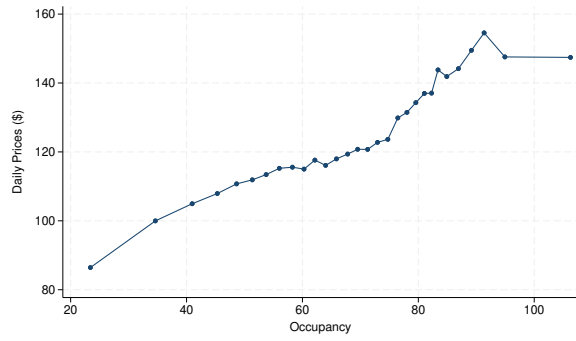|	Prices			Occupancy		
Percentile	5th	50th	95th	5th	50th	95th
Luxury	134.15	206.59	305.39	24.40	71.34	98.38
Upper Upscale	96.49	136.08	201.04	31.76	74.56	97.71
Upscale	78.58	110.58	160.39	32.47	72.31	97.41
Upper Midscale	64.24	94.18	144.18	33.97	67.07	96.72
Midscale	51.09	70.19	103.78	23.45	59.04	95.35
Economy	43.94	54.92	93.49	32.27	57.52	88.90
Airport	45.66	85.15	150.46	35.42	69.66	97.71
Urban	50.56	88.34	181.63	27.91	60.72	94.85
Other	54.95	121.36	243.15	29.75	69.41	97.41

Note: Observations include 191,648 segment-night observations across 15 MSAs from 2015-2017 and represent the sample used for model estimation. Categories shown are the Class quality tiers for hotels and location categories.

The assumption that cost curves are increasing and convex (see Figure 1) cannot be directly observed in the data, as observed equilibrium values are jointly determined by supply and demand. A reasonable assumption is that if the pattern of outcomes in the data is still driven by this feature of the market, it should be observable given the wide range of occupancy values in the data. Showing data from four major MSAs, Figure 2 demonstrates that prices in the data increase steeply as market segments approach full capacity utilization. A possible explanation for the flattening of the relationship at full occupancy is that these observations may correspond to idiosyncratic events which have atypical pricing schedules.

The rest of this section highlights facts about the data at the level of firms, and the identifying variation for the supply side of the model. Table 4 summarizes the distribution of relevant statistics for occupancy rates and firm size, listing the mean, standard deviation, and 5th, 50th, and 95th percentiles of each variable. Firms have a wide range of observed occupancy rates, with 25% of observations above 87% occupancy and 5% above 99%, which suggests that firms are capacity constrained even when considering the problem as one of joint capacity utilization across the firm's properties. The modal firm is an independent, with one property operated in one market segment. Unsurprisingly, there is substantial variation in firm size in terms of the number of properties and rooms, and the number of market segments the firm operates across. While only 25% of firms have at least 2 properties per segment, the top 5% operate 8 and the top 1% operate 16, providing considerable range of scale in the observable data.

Underlying this range in scale is that the hospitality sector has been consolidating over the past several decades (Roper (2018)). This is driven by two factors: consolidation under large, global hotel chains (see Section 2 for examples in the data sample), and the expansion of franchising as
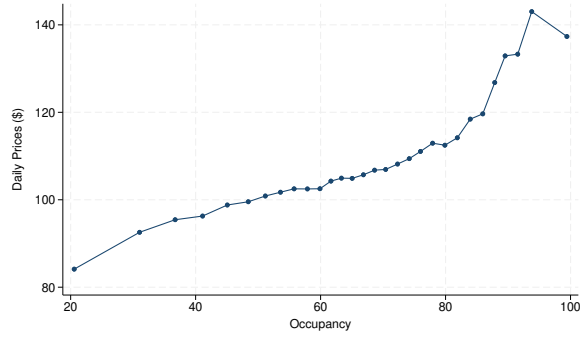
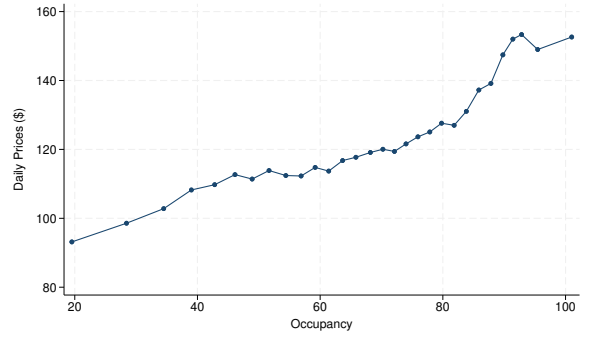FIGURE 2: Relationship Between Prices and Occupancy Rates

(A) Austin, TX
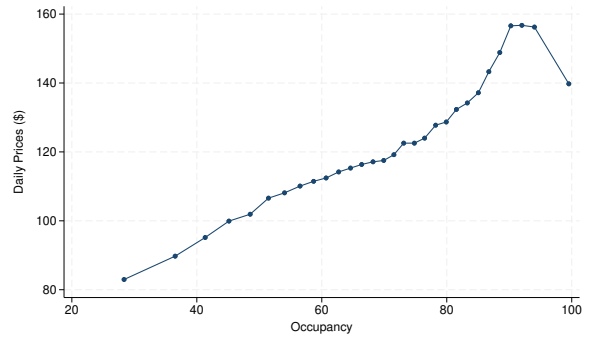
(B) Chicago, IL

(C) Indianapolis, IN

(D) Madison, WI

Note: Figures plot binned scatterplots of MSA-segment-night-level ADR on occupancy rates, absorbing segment-level fixed effects.

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Table 4: Distribution of Firm-level Prices, Quantities, and Size

	N	Mean	SD	5 pct	Median	95 pct
Average Daily Rate (ADR)	692,769	106.10	48.59	50.15	97.11	200.36
Daily Occupancy Rate	692,769	0.66	0.24	0.25	0.68	0.99
Number of Operated Properties	692,769	2.27	2.92	1	1	8
Number of Operated Rooms	692,769	327.04	370.71	35	225	1000
Operated Market Segments	692,769	4.44	2.92	1	4	10

Note: Observations include 180 unique firms with 301 unique firm-segment operations across 15 MSAs from 2015-2017. ADR, occupancy, operated properties and operated rooms list the distribution at the firm-MSA-segment level. Operated market segments lists the distribution of the number of market segments each firm operates in within a given MSA.

a lower-risk method for large chains to enter new markets. From 2015 to 2017, the firm-segment average number of rooms operated has risen from 319 to 339, while the firm-segment property count has also risen from 2.21 to 2.37. During this period, 21% of hotels in the data changed ownership at least once, 3% changed at least twice. Figure 3 plots the trend in mean HHI across daily markets, weighted by the number of rooms sold per market. While in this paper I treat the market definition as all classes and locations within the MSA, quality and location-based measures of local competition are frequently considered and so I present values using a market definition of the MSA-location category, split between low (economy, midscale, and upper midscale) and high (upscale, upper upscale, and luxury) segments.[23] Segments are highly concentrated, with concentration increasing visibly in the high-quality segments following the merger of Marriott and Starwood in September 2016, and in the low-quality segments following the merger of Wyndham and La Quinta in January 2018.

While I do not conduct a formal merger retrospective in this paper as to avoid drawing strict conclusions on parent companies in anonymized financial data, I note the observations of Armona et al. (2021), who perform an event study on the merger of Marriott and Starwood in several US states using an index for the exposure of a given geographical market and class segment to the merger. The authors find that there were substantial price decreases following the completion of the merger in market segments where the merger had high exposure, relative to segments in the same geographical market without exposure. They attribute these effects to cost reductions related to administrative centralization (see Dogru et al. (2018)). I take this as motivating evidence for the presence of cost efficiencies following mergers which may be passed through to consumers.

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[23]See citations in Section 2.3. Agencies considered 4 and 5-star hotels as relevant competition in Marriott-Starwood, and economy and midscale hotels as the relevant market for Choice-Wyndham.

FIGURE 3: Trends in Daily Mean HHI by Quality Bracket (2014-2018)
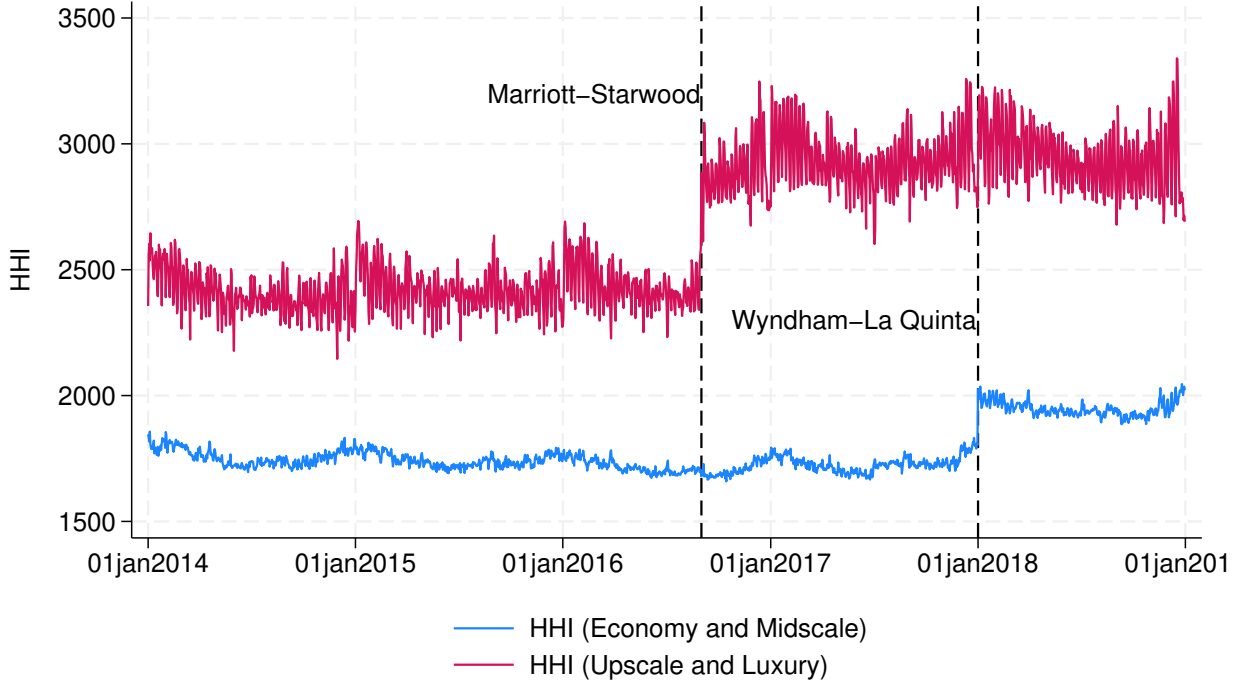
Note: HHI is defined across submarkets defined as {Economy, Midscale, and Upper Miscale} and {Upscale, Upper Upscale, and Luxury} quality hotels, separated by location category and MSA on each night. Vertical lines indicate the months where the two largest mergers in the data occurred, corresponding to changes in HHI in the affected markets.

4   Model and Estimation Strategy

In this section, I discuss the model of consumer demand, firm supply, and their identification and estimation. I first discuss the demand model, through which I estimate markups and recover marginal costs from observed prices and quantities. Using the recovered firm-level costs, I estimate firms' non-linear marginal cost functions where variation in cost is explained by occupancy rates, the amount of installed capacity, and unobserved firm-level cost shocks.

4.1   Demand

I specify a nested logit demand model for lodging choices. Consumers make discrete choices over lodging options h and an outside option ($u_0 = 0$) each MSA-night n. The product space of segments h is defined by categorical quality s and location ℓ, where locations are treated as separate nests.

Utility for the consumer choosing option h is written:

$$u_{hn} = x_{hn}\beta + \alpha p_{hn} + \xi_{hn} + e_{\ell n} + (1-\rho)\epsilon_{hn} \tag{1}$$

where x denotes a vector of observable demand shifters, ξ is an unobserved demand shock, and ρ is a parameter reflecting correlation within the nest ℓ. e and ϵ refer to nest- and segment-level errors such that $e_{\ell n} + (1-\rho)\epsilon_{hn}$ follows a Type 1 Extreme Value distribution. Hotels within each class h are aggregated and treated as homogeneous products: the segment-level price p_{hn} is observed as a quantity-weighted average of the hotel prices p_{jn} in the segment-MSA-night.

I define the market sizes M_n in each MSA using a multiple of the maximum rooms sold in an MSA following Lewis and Zervas (2019) and Farronato and Fradkin (2022): $M_n = 2 \times \max_n \sum_{hn} q_{hn}$, a constant within each MSA. The consumer decision is independent across nights: I abstract away from any collinearity between the representative consumer's choice of hotel in subsequent nights. Quantities for segment h in nest ℓ are thus:

$$Q_{hn}(p_{hn}, p_{-hn}) = M_n \cdot \frac{\exp[V_{hn}/(1-\rho)]}{\exp[V_{\ell n}/(1-\rho)]} \cdot \frac{\exp V_{\ell n}}{1 + \sum_k \exp V_{kn}} \tag{2}$$

given $V_{hn} = x_{hn}\beta + \alpha p_{hn} + \xi_{hn}$ and $V_{\ell n} = \sum_s V_{\ell sn}$. The nested logit estimated equation is:

$$\log s_{hn} - \log s_{0n} = x_{hn}\beta_h + \alpha p_{hn} + \rho \log s_{hn|\ell n} + \xi_{hn} \tag{3}$$

The linear characteristics x_{hn} contain a time trend interacted with MSA fixed effects, segment-MSA-month fixed effects to reflect the quality of different market segments across cities and their respective seasonality, and day-of-week fixed effects to capture trends within the week (such as the variation between weekday and weekend travel). I also include several weekly demand shifters: the weekly Google search rank $G \in [0, 100]$ for "hotels [MSA]" in the prior week, the segment occupancy rate in the same week in the prior year, and the segment occupancy rate on the same day and prior day in the prior year, each interacted with segment-level fixed effects. The parameter ρ reflects spatial differentiation across locations (nests) $\ell \in \{\text{Downtown, Airport, Other}\}$.

The logit demand model provides for a closed-form expression of consumer surplus for each MSA-night n, given an unobserved constant of integration C:

$$\text{CS}_n = \frac{1}{\alpha} \log \left(1 + \sum_\ell \left(\sum_s \exp \frac{V_{\ell sn}}{1-\rho}\right)^{1-\rho}\right) + C \tag{4}$$

The choice of demand model—and the compromises involved in aggregating away product-level variation—is based on several considerations. A major challenge in estimating hotel demand at the hotel level is the presence of capacity constraints.[24] In markets where products are sold out – in this context, where hotels are at full capacity – the workhorse aggregated-demand estimator of Berry, Levinsohn, and Pakes (1995) is misspecified as we only observe a restricted measure of demand for products, making it impossible to invert the demand system and recover unique values for ξ. The substitution patterns that I would recover are also incorrect. Consumers face different choice sets as hotels go in and out of stock, and hence make different substitutions based on what products are available at different times. This added heterogeneity of choice sets provides for more complex substitution patterns than random coefficients on preferences can provide. Considering all possible choice sets is also computationally challenging: Conlon and Mortimer (2013) provides one such example of incorporating these aspects, or requires unavailable microdata to identify latent choice sets as in Agarwal and Somaini (2022).[25]

A final concern of taking a differentiated-products approach is that my data do not provide a high degree of product differentiation. Anonymity requirements of the data result in hotels having no attached identifying characteristics, including any finer geographic details within their MSA. This lack of spatial consideration could result in implausibly-similar substitution patterns between hotels in the same city but many miles apart compared to closer rivals. Armona et al. (2021) demonstrate one answer to this problem, through a search model which recovers consumer preferences using Expedia search data.

4.2 Supply

Firms—indexed by f—engage in static Cournot-Nash competition. Each firm chooses a vector of market-segment-level quantities $\mathbf{Q}_f$ of rooms to sell for each night n.[26] The firm problem is treated as unconstrained: quantity choices are instead soft-bounded by convex, increasing costs which rise after a threshold level of occupancy ϕ rather than imposing Kuhn-Tucker conditions. Firms are hence more unwilling to sell rooms as they approach full occupancy without substantially higher prices. The nonlinearity between prices and occupancy rates in the hotel market is well-

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[24]There are several other solutions to the issue of identification in the presence of stockouts which are not suitable to this case. Eliminating stockout observations by aggregating instead to—for example—the hotel-week level would smooth the relationship between prices and quantities near the capacity constraint, and limit identification of the main parameters of the supply model. Alternatively, removing out-of-stock products or periods would limit variation in the instrumental variables for price, and further weaken the identification of the supply parameters.

[25]On the other hand, Berry and Jia (2010) provide evidence that the bias is small in data where the choice set is aggregated and product shares are not overly large.

[26]A Cournot model allows firms to have non-zero markups given the homogeneity assumption in the demand system. As hotels are homogeneous, hotel-level quantity decisions within the firm are not meaningful, and hence I write the problem at the firm level.

documented, and so the functional form of costs allows for flexibility in the cost function based on occupancy (see Kalnins et al. (2017), Cho et al. (2018), and Farronato and Fradkin (2022)). Prices are determined at the market segment level, and are shared by all firms: the inverse demand function $p_{hn}(Q_{hn}, Q_{-hn})$ takes into account the sum of quantities per segment $Q_{hn} = \sum_f Q_{fhn}$.

Equation 5 shows the firm's profit-maximization function, omitting subscripts for the MSA-night n as these decisions are independent:

$$\Pi_f(\mathbf{Q}_f, \mathbf{Q}_{-f}) = \max_{Q_f} \sum_h \left[Q_{fh}(p_h(\mathbf{Q}_f, \mathbf{Q}_{-f})) - C_{fh}(Q_{fh}) \right] \tag{5}$$

The cost function $C_{fh}(Q_{fh})$ is written as two separable terms, reflecting linear operational costs—the cost of selling a room—λ_1 and non-linear occupancy-based opportunity costs λ_2 that relate to the cost of selling constrained capacity:

$$C_{fh}(Q_{fh}) = \lambda_{1,h} Q_{fh} + \lambda_{2,h}(Q_{fh}) \tag{6}$$

The structure of the cost function aims to capture three sources of variation in costs. First, the shape of the nonlinear segment of the cost function λ_2 (the impact of the soft capacity constraint) reflects variation in costs across occupancy rates within firms. Next, asymmetries in costs across firms of different sizes are reflected through variation in costs at all occupancy rates (linear cost asymmetry in λ_1) and variation in the relationship between costs and occupancy at high occupancy rates (nonlinear cost asymmetry in λ_2). These latter two sources of asymmetry reflect the presence of economies of scale, through decreasing average and marginal costs when the firm is larger, and additionally through the implication that asymmetries in cost shocks can be smoothed by consolidation.

I parameterize the cost function in Equation 6 as follows:

$$C_{fh}(Q_{fh}, \nu_{fh}, \mu_{fh}; \gamma, \theta_s) = \underbrace{(c_h + \gamma \log \bar{Q}_{fh} + \mu_{fh}) Q_{fh}}_{\text{Linear Costs } \lambda_1} + \underbrace{\frac{Q_{fh}}{1 + \eta} \left(\frac{Q_{fh}}{\phi \cdot (\sum_{j \in \mathcal{J}_{fh}} \bar{q}_j^r)^{1/r}} \right)^\eta}_{\text{Non-linear Costs } \lambda_2} \tag{7}$$

where ν_{fh} reflects firm-level attributes in the segment and θ_s is the set of nonlinear parameters (ϕ, η, r). The linear cost term includes segment-level costs c_h which are symmetric across all firms in that segment, an unobserved cost shifter μ_{fh} with assumed conditional expectation $E[\mu_{fh}|Q_{fh}, \nu_{fh}; \gamma, \theta_s] = E[\mu_{fh}] = 0$, and a term linear in log capacity $\bar{Q}_{fh}$ which captures dis-

persion in costs at all occupancy levels that are related to the magnitude of firm capacity. The nonlinear segment of costs is governed by the soft capacity threshold ϕ and the sharpness of the cost constraint η, which reflect variation in costs across occupancy rates. These parameters are not restricted in the values they may take: Equation 7 is flexible and allows variation in the data to determine the shape of the cost function. While *a priori* I assume this function is convex and increasing, this property of the cost function is not enforced by the modeling assumptions ($C_{fh}(\cdot)$ is linear in Q_{fh} if $\eta = 0$).

The denominator of the cost function's nonlinear term is a CES-style aggregator of the capacities of the hotels j in firm f's portfolio $\mathcal{J}_{fh}$ in that segment h, where $\sum_{j \in \mathcal{J}_{fh}} \bar{q}_j = \bar{Q}_{fh}$. The efficiency parameter r captures potential (dis)economies of scale accrued from operating more than one hotel in the same market segment: asymmetries in costs across firms of different sizes at high occupancy rates. For values of $r < 1$ and more than one operated hotel, the aggregator's value is greater than the simple sum of capacities $\bar{Q}$, and hence the value of the convex-and-increasing term falls at all values of Q. Hence, if the data indicate a value of $r < 1$, it suggests that scale tends to soften the capacity constraint and decrease costs at high occupancy rates. The firm's problem captures the outcome of joint capacity utilization, where properties are imperfect substitutes for one another but can pool capacity to offset (unobserved) diverse demand and reduce the cost of supplying rooms at high occupancy rates.

Equation 5 produces the firms' first order condition for profit maximization:

$$p_{hn} + \left(\Omega^* \cdot \frac{\partial p}{\partial Q} \right) Q - \frac{\partial C(Q_{fh})}{\partial Q_{fh}} = 0 \tag{8}$$

given marginal costs $\frac{\partial C(Q_{fh})}{\partial Q_{fh}}$, which are smooth, continuous, and nonlinear based on the shape parameters (ϕ, η). Cournot-Nash markups are $\Omega = -\left(\Omega^* \cdot \frac{\partial p}{\partial Q} \right) Q$ at the firm-segment-MSA-night level, and Ω^* is a block diagonal ownership matrix.[27] Given that markups are estimated through the inverse demand system $p_h(\mathbf{Q}_f, \mathbf{Q}_{-f})$, the supply estimation equation is:

$$p_{hn} - \Omega_{fhn} = c_{hn} + \gamma_m \log \bar{Q}_{fhn} + \left(\frac{Q_{fhn}}{\phi_\ell \cdot (\sum_{j \in \mathcal{J}_{fn}} \bar{q}_j^r)^{1/r}} \right)^\eta + \mu_{fhn} \tag{9}$$

I allow the parameters γ and ϕ to vary across market categories: γ is interacted with fixed effects at the MSA level m as different MSAs will have different inherent market sizes. ϕ is interacted with nest fixed effects as different location types may have different base market tightness.

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[27]Appendix B lists the full equations for elasticities and markups.

4.3 Identification and Estimation

I estimate the demand system—Equation 3—using 2SLS with one instrument per endogenous regressor. The just-identified framework allows for several best-practices for weak instrument testing (see Andrews, Stock, and Sun (2019)).

The demand model faces two sources of endogeneity: prices (α), and the within-nest correlation (ρ). Common approaches for instruments are unsuitable: as noted by Armona et al. (2021), hotel cost shifters are not readily available. For example, many costs are contracted such that even if labor prices are observed, they do not exogenously affect prices at the frequency of the observed data. Additionally, using the within-nest number of products does not provide useful variation as the number of hotels in a market does not frequently change.

To identify the coefficient on prices, I exploit the presence of capacity constraints, which are excluded from mean utility δ. Conditional on the magnitude of demand, segments with fewer available rooms face higher opportunity costs: the constraint acts as a supply shifter, steepening the relationship between prices and quantities. I proxy for this effect by utilizing the ratio of the exogenous variation in demand to the number of rooms $\bar{q}$ in segment h, constructing predicted quantity $\hat{q}$ as a function of demand shifters x_{hn} and fixed effects. Each of the continuous variables is interacted with segment-MSA-level fixed effects, except the timetrend interacted with market-level effects.

$$z_{hn}^{\alpha} = \frac{\hat{q}_{hn}}{\bar{q}_{hn}} \quad \text{given} \quad log(\hat{q}_{hn}) = x_{hn}\hat{\beta}_{hn} \tag{10}$$

The identification strategy for ρ considers the relative expensiveness of a segment compared to local rivals within the same nest ℓ. I construct the predicted price $\hat{p}$ using exogenous variation: the same observed characteristics and fixed effects as Equation 10, along with the price instrument z_{hn}^{α} interacted with product-MSA fixed effects. The instrument for the nest share $z_{\ell sn}^{\rho}$ equals the sum of differences between the predicted price and the predicted price of within-nest rival segments:

$$z_{\ell sn}^{\rho} = \sum_{s' \neq s} \left(\hat{p}_{\ell sn} - \hat{p}_{\ell s'n} \right) \quad \text{given} \quad log(\hat{p}_{hn}) = x_{hn}\tilde{\beta}_{hn} + \tau_{hn}z_{hn}^{\alpha} \tag{11}$$

Both instruments are then normalized to mean-zero, standard deviation 1, in order to remove differences in scaling which would impact estimation. To account for correlation in observed market data, I cluster observations at the MSA-year-month level when computing standard errors.

Computation of markups $\Omega = -\left(\Omega^* \cdot \frac{\partial p}{\partial Q} \right) Q$ from the estimated demand system allows for the recovery of marginal costs, and hence allows the estimation of the cost function as a nonlinear

IV problem. Identification of the cost function relies on two sources of variation. The first is variation in demand shifters, which trace out the shape of the supply curve for each firm and allows for identification of the shape parameters ϕ and η. The second is variation in firm size—both cross-sectionally and over time as ownership changes in the data—which identifies the linear cost parameter γ and the nonlinear efficiency parameter r from asymmetry in recovered costs across firms of different sizes which face similar demand.

I construct two sets of instruments. First, to define instruments for the nonlinear coefficients $\theta = (\phi, \eta, r)$, I utilize the functional form of the optimal instruments for each variable.[28] To approximate evaluating the optimal instruments at post-estimation values, I utilize calibrated starting values for the nonlinear parameter estimates and instrument for quantities:

$$\left[z_{fhn}^{\phi}, \ z_{fhn}^{\eta}, \ z_{fhn}^{r}\right] = E\left[\frac{\partial \hat{\mu}_{fhn}}{\partial \theta_s}\bigg|z_{fhn}^{q}, \hat{\theta}_s\right], \tag{12}$$

given $\hat{\theta}_s = (\hat{\phi}, \hat{\eta}, \hat{r}) = (0.8, 10, 0.97)$ and predicted exogenous variation in occupancy using demand shifters ω_{fhn}:[29]

$$\log z_{fhn}^{q} = \log o\hat{c}c_{fhn} = \omega_{fhn}\hat{\lambda}_{hn} \tag{13}$$

Second, I create additional instruments to identify dispersion in costs due to firm size. Aside from the exogenous variables $\bar{Q}_{fhn}$ interacted with MSA-level fixed effects, I define a set of instruments $\bar{z}_{fhn}$ as interactions between the threshold instrument z_{fhn}^{ϕ} and the number of rooms and hotels owned by firm f in segment-night hn. As firm size effectively shifts the impact of the capacity threshold ϕ through the nonlinear parameter r, this interaction of firm size and the identifying variation for ϕ improves identification for r.

Using the full set of supply instruments and exogenous variables $Z_{fhn}^{s} = [\hat{\theta}_s, \ \bar{z}_{fhn}, \ \bar{Q}_{fhn}]$ and assuming that $E[\mu_{fhn}|\cdot] = E[\mu_{fhn}] = 0$, I construct the set of moments $m(\theta^s)$ and minimize the objective function $q(\theta^s)$ using a 2-step approach:

$$
\begin{aligned}
m(\theta^s) &= \sum \mu_{fhn} \cdot Z_{fhn}^{s} \\
q(\theta^s) &= m(\theta^s)'Wm(\theta^s)
\end{aligned}
\tag{14}
$$

where W is an initial weight matrix configured for MSA-year-month clustering.

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[28]Optimal instruments are defined as the derivative of the moment condition with respect to the parameter evaluated at the consistent estimate of the function (Chamberlain (1987), Reynaert and Verboven (2014)).

[29]These are the same demand shifters as in the demand system, but taken at the firm level rather than the segment level. Calibrated starting values were initially chosen to fit expected patterns from the literature, and updated based on iteration of the problem towards estimated parameter values.

5 Results

In this section, I report parameter estimates for the demand and supply models, as well as the recovered markups and marginal costs from the model estimates. Additionally, I present a summary of the markup and cost changes across firms of different sizes to visualize the effects of the non-linear cost parameters.

5.1 Demand Parameter Estimates

Table 5 presents the estimated coefficients of the nested logit demand model. The key parameters (α, ρ) are statistically-significant at the 1% level. I present both the logit (Specification (1)) and nested logit (Specification (2)), alongside test results for weak-instrument detection suited to non-homoskedastic standard errors.[30]

My estimated own-price elasticities for the nested logit model in Specification (2) by quality class range from -6.56 for luxury hotels to -1.83 for economy hotels. Comparing my estimates literature values, I find a range of -6.14 for luxury to -1.96 for economy versus -7.49 to -1.59 by Farronato and Fradkin (2022) for Austin, TX. However, the compared literature values incorporate a more complex specification with variation in price preference, and a different product space.[31] Own-price elasticities also vary intuitively by location: airport hotels face less price-sensitive demand with own-price elasticity of -2.43 compared to urban hotels with -3.73. Appendix E contains more details on estimated elasticities.

5.2 Recovered Costs

In Table 6, I summarize the recovered markups and costs. The values pass a useful sanity check: mean segment-level costs are monotonic and increasing in quality. However, a subset of observations are outliers: high-cost and low-quantity San Antonio luxury hotels recover extremely high markups and hence disproportionately low costs in those periods. I present kernel densities of marginal costs and markups in Appendix Figure 7. Markups are computed at the firm level using firm-level demand elasticities: when more than one firm is present, firm-level elasticities are higher than the

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[30]I report the effective F statistic of Montiel and Pfluenger (2013) for $k = 1$ and the Kleibergen and Paap (2006) robust F statistic for $k = 2$. See the notes of Table 5.

[31]I note that while Farronato and Fradkin (2022) estimate random coefficients on both the constant and price, neither estimate of standard deviation is statistically significant. They also do not incorporate location differentiation within markets: the logit model estimates, which do not differentiate by location nest, find a more similar range of -7.54 to -2.51.

TABLE 5: Estimated Demand Coefficients

		(1)		(2)	
α	Price	-0.039***	(0.005)	-0.015***	(0.002)
ρ	log Nest Share	-	-	0.552***	(0.076)
Number of Observations		191,648		191,648	
Specification		Logit		Nested Logit	
Median Own-Price Elasticity		-3.60		-2.67	
Estimator		2SLS		2SLS	
Excluded Instruments		z_{hn}^{α}		$z_{hn}^{\alpha}, z_{hn}^{\rho}$	
F Statistic		136.9		35.4	
AR χ^2		85.07		102.62	

Note: *** $p < 0.01$. The β coefficients are excluded for brevity. Estimation sample includes daily category-level observations from 15 MSAs from 2015-2017. All specifications include fixed effects at the segment-MSA-month and day-of-week levels. Standard errors are clustered at the MSA-year-month level. For weak identification testing, Specification (1) reports the Montiel-Pflueger Effective F statistic, while Specification (2) reports the Kleibergen-Paap Robust F statistic. Sanderson-Windmeijer F statistics for Specification (2) are 72.4 (prices) and 132.9 (log inside-nest share).

reported segment-level elasticities due to the presence of (homogenous) substitutes.[32]

TABLE 6: Summary of Recovered Markups and Costs

|		Prices		Markups		Marginal Costs	
	N	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Luxury	35,502	215.7	57.5	19.8	16.7	195.9	60.2
Upper Upscale	138,481	146.0	39.1	13.2	11.3	132.8	41.3
Upscale	121,334	116.0	27.4	16.5	10.7	99.5	28.9
Upper Midscale	166,195	98.7	24.0	13.1	11.0	85.6	25.0
Midscale	104,335	73.2	17.4	16.5	17.2	56.7	24.4
Economy	126,922	59.2	15.0	12.5	10.0	46.6	16.5
Total	692,769	106.1	48.6	14.5	12.5	91.6	49.3

Note: Observations are presented at the firm-MSA-night level.

While costs (and hence markups) are partially an abstraction in this context, they can be validated against data. The nested logit specification obtains (slightly) more inelastic estimates than other literature values. Additionally, the Cournot-Nash model of conduct produces higher markups than an equivalent Bertrand model (Magnolfi, Quint, Sullivan, and Waldfogel (2022)). On the other hand, data from the STR Global Hotel Profitability Review for US Midscale/Economy Hotels—where revenue per occupied room is almost entirely captured by ADR and hence there are few confounding revenue channels—reports mean EBITDA of \$32.33 on ADR of \$80.41 (40.2%). I do not have estimates for the non-included fixed expenses and non-operating expenses which are considered when management makes pricing decisions, but as a preliminary point this suggests my

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[32]Mechanically, $|\frac{\partial Q_h}{\partial p_h} \frac{p_h}{Q_h}| \leq |\frac{\partial Q_h}{\partial p_h} \frac{p_h}{Q_{fh}}|$ if $Q_h \geq Q_{fh}$. Hence, firm-level elasticities are higher in magnitude than segment-level elasticities, and this greater elasticity results in lower markups at the firm level.

estimates for markups ($16.52, or 22.3% for Midscale hotels) are not dramatically overstated.

FIGURE 4: Recovered Marginal Cost Values
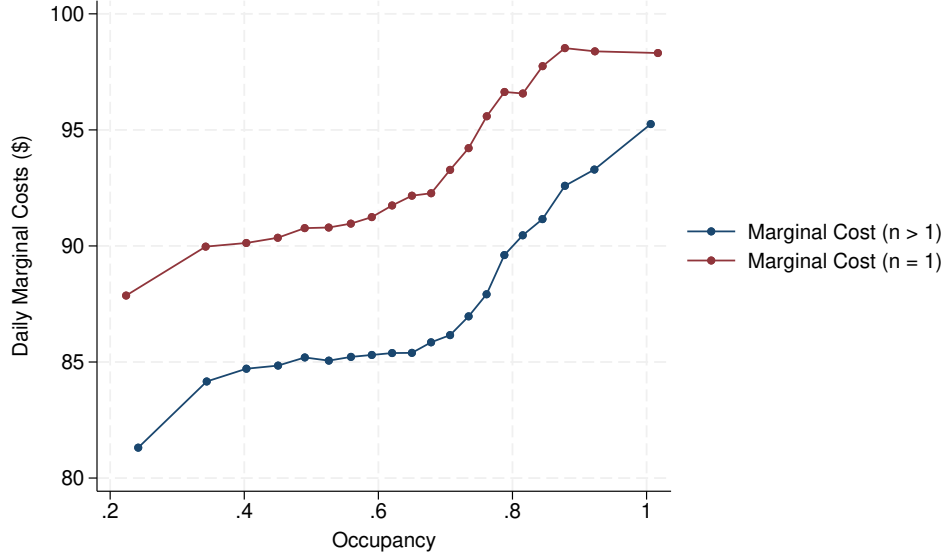
Note: Figure plots a binned scatterplot of recovered marginal cost values for firms with a single ($n = 1$) property in the market segment, and for all firms with more than one ($n > 1$) property in the segment. Seasonal and cross-market effecst are captured via segment-MSA-year-month fixed effects.

Figure 4 displayed binned scatterplots of the recovered marginal costs on occupancy, for firms with $n = 1$ or $n > 1$ properties in their market segment. Values shown control for interactions of market segment, MSA, and year-month. Firms with larger ($n > 1$ properties) portfolios have lower marginal costs at all occupancy rates.

5.3 Supply Parameter Estimates

Table 7 summarizes the supply specification coefficient results. I estimate a threshold parameter of 0.65 to 0.75. This is lower than values in the literature (Kalnins et al. (2017) cite a range of 80% to 85% while Farronato and Fradkin (2022) use values of 0.85), though this can be explained by the difference in functional form. Urban hotels are the most tightly capacity-constrained, while airport hotels are the least. All parameters are statistically significant at the 1% level. The linear cost parameters on the log number of rooms (γ_m) are omitted from the table, but are statistically significant and less than zero in all cases. Furthermore, I am able to reject the hypothesis that scale is irrelevant to the nonlinear capacity constraint ($r = 1$).

Figure 5 displays bootstrapped confidence intervals on two aspects of the estimated coefficients.

TABLE 7: Selected Estimated Supply Model Coefficients

Parameter		Category	(1)	
Threshold	ϕ	Airport	0.753***	(0.024)
		Urban	0.652***	(0.028)
		Other	0.718***	(0.022)
Sharpness	η		9.525***	(0.925)
Efficiency	r		0.978***	(0.004)
Observations	N		692,769	

Note: *** $p < 0.01$. Specification contains segment-MSA, year-month, and day-of-week fixed effects. Standard errors are clustered at the level of MSA-month-year. Omitted γ coefficients are negative and statistically significant at the 1% level.

Panel A shows the added convex marginal costs as a function of occupancy for a firm with 1 or 3 identical hotels and a base $c_h = 100$. As occupancy rates approach 100%, marginal costs rise by approximately $50. The difference in marginal costs between the two firms begins at $8.30 at low occupancy rates, driven by differing linear costs from scale (γ). At full occupancy, the difference in marginal costs rises to $17.62, where the additional difference ($9.32) results from non-linear efficiencies (r) where the soft capacity constraint has less impact on the costs of the larger firm.

Panel B visualizes the impact of the efficiency parameter through the added nonlinear marginal costs at an occupancy rate of 99% for firms operating $\{1, \ldots, 8\}$ identical hotels of 100 rooms: the y-axis demonstrates the difference between the marginal costs at high occupancy versus low occupancy. The cost-reduction effects are most pronounced at lower values: the acquisition of independent or isolated hotels has a larger effect than the merger of two large overlapping chains. Non-linear marginal costs fall from $50.96 for an independent firm to $45.47 and $42.54 once the firm holds $n(\mathcal{J}) = 2$ and 3 respectively. This result implies that efficiency gains in terms of cost reductions diminish in firm size. A merger of two smaller or independent firms stands to reduce costs at the constraint for both the acquirer's and target's capacities. On the other hand, larger chains—the usual focus of regulatory attention—have already internalized much of the potential efficiency with respect to the capacity constraint and allocating quantities, mergers will have limited subsequent effects on this channel of efficiency, though when acquiring smaller rivals the average cost on the acquired capacities will still fall. In Appendix C, I display the magnitudes of cost and markup changes within a broader market from changes in firm sizes, holding quantities constant.

6   Counterfactual Analysis

Using the estimates for the demand and supply systems in Section 5, I construct two counterfactual scenarios. These cases the short-run static environment where firms do not engage in strategic

FIGURE 5: Bootstrapped Parameter Effects on Marginal Cost Function

(A) Estimated Convex Costs

(B) Estimated Scale Effects
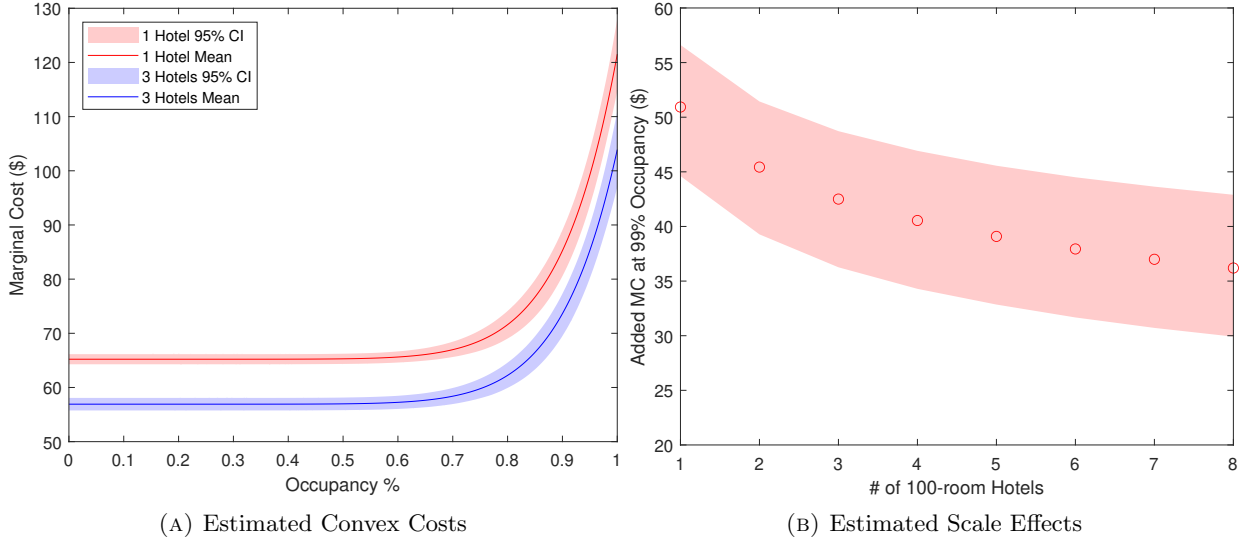
Note: Figure presents means and bootstrapped 95% confidence intervals of (A) the estimated cost function given a baseline marginal cost $c_h = 100$ in an urban location, and (B) the value of the nonlinear marginal cost term λ_2 at 99% occupancy for a hypothetical firm with $1, \ldots, 8$ identical 100-room properties in the segment.

repositioning and there is no potential for entry. The first considers the impact of large parent company mergers via simulating a case where the 2016 merger of Marriott and Starwood did not take place. The second explores the marginal and cumulative effects of a series of small acquisitions by a single large parent companies, and considers welfare effects given antitrust enforcement. I explain the details of constructing the counterfactual equilibria in Appendix D.

In the following analyses, I focus on consumer surplus as the primary metric for evaluating the competitive impact mergers. An advantage of this is that the interpretation of cost (opportunity or accounting) does not affect consumer utility (but would impact total surplus). This choice of metric also allows me to aggregate the effects of mergers across product segments of different quality and directly compare the effects across MSAs.

6.1 Large Firms: the Case of Marriott and Starwood

In the first counterfactual, I examine how the consumer welfare effects of large mergers depend on initial market conditions by considering Marriott-Starwood merger across different markets.[33] Using data for 8 MSAs where both firms have non-zero capacity in 2016, I restore the pre-merger hotel-level ownership structure from August 2016 in the data for 2017. Based on the Agencies description of the relevant competitive market, I focus on the upscale, upper upscale, and luxury

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[33]The merger, including firm rationale and regulatory responses, is discussed in Section 2.3.

tier of hotels within each MSA, separated by the location categories defined in this paper.[34] Within the markets I am considering (summarized in Appendix Table 3), the pre-merger firms earn an average of 36.8% of market revenues, with a closely-related share of the rooms installed. Markets vary by HHI (1,092 to 3,900, with an average of 2,467) and the naive change in HHI (henceforth DHHI, 0 to 1,880, with an average among non-zero markets of 711): given the market share held by the merging parties, almost all markets immediately fail the structural presumption put forth by the 2023 Merger Guidelines.[35]

Table 8 presents a market-level summary of the differences between the pre and post-split equilibria. All markets see a decrease in total rooms sold over the course of the year. The increase in consolidation raises average markups within each market, but gained merger efficiencies drives a fall in average costs in all markets except Madison, WI, which in turn is the only market to report a fall in counterfactual profits. Consumers would be worse off in all markets except for Madison, WI ($0.88 million annually) and Milwaukee, WI ($0.13 million annually) where the gain in efficiency sufficiently outweighs increases in markups. Unsurprisingly for its size, the merger—when assessed by standards of consumer harm—is generally negative. The counter-intuitive outcomes for Madison and Milwaukee are driven by the high degrees of overlap in limited market segments between the two firms: in each case, the firms primarily operate in upper upscale segments but are not majority players in the entire market (see Appendix Figures 9 and 10). By contrast, Chicago, IL, the largest market which sees substantial overlap across multiple market segments, has the highest fall in consumer surplus ($-\$7.95$ million) from the split.

TABLE 8: MSA-level Summary of Merger Effects

Market	Δ Q	Δ AC	Δ Ω	Δ CS	Δ Π	Δ W
Chicago, IL	$-106,662$	-1.19	0.79	-7.95	5.02	-2.93
Houston, TX	$-48,602$	-2.60	1.86	-3.73	5.42	1.70
Indianapolis, IN	$-43,034$	-1.24	0.73	-4.22	3.77	-0.45
Kansas City, MO	$-68,817$	-2.02	1.42	-5.11	5.56	0.45
Madison, WI	$-46,854$	0.10	0.35	0.88	-1.37	-0.49
Milwaukee, WI	$-29,621$	-0.94	0.81	0.13	0.74	0.87
Saint Louis, MO	$-37,643$	-0.69	0.45	-2.05	1.85	-0.19
San Antonio, TX	$-19,465$	-1.63	0.74	-0.29	0.40	0.11

Note: Quantity changes reflect the total change in rooms sold over the course of 2017. Consumer surplus (CS), profit (Π), and total welfare (W) values are presented in millions of USD. All values are presented as the sum of changes over the course of 2017, except for average costs (AC) and markups (Ω) which are displayed as the mean change across all firms and dates.

The merging firms generally raised their prices (1.34% on average) more than non-merging firms

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[34] *Brown Shoe* factors allow for practical market definitions such as industry sub-markets: the focus on competition from 4 and 5-star rivals is an example of such.

[35] The U.S. Department of Justice and Federal Trade Commission (2023) suggest a threshold for structural presumption at post-merger HHI of 1,800 with a change of at least 100, or if the post-merger firm has market share of over 30%.

(0.63%): as prices are defined at the market segment level, this indicates that segments that did not further consolidate were less impacted in terms of price.[36] The merging firms largely reduced their occupancy rates (−6.93%) despite increased efficiencies, which in turn led non-merging firms to be willing to target higher occupancy rates (1.24%) given increased prices in consolidating segments. There is little pass-through of efficiencies: while non-merging firms faced little change in average costs (0.01%) and merging firms reduced their average costs (−2.19%), this was offset by increases in markups arising from increased concentration (see Appendix Figure 11 panels C and D). Merging firms increased markups by an average of 60% versus an increase of 1.38% for non-merging firms. As markups are an abstraction in this context—costs are a minimum price threshold rather than a literal operational cost—it is unsurprising to see large swings in the estimated value. However, the substantial range of increases suggests that decreases in costs are in many cases recaptured as profits by the merging firm.

While initial and changed market concentration are a predictor of consumer welfare losses, I also consider predictors for when non-linear efficiencies are most substantial. During periods where market-level occupancy rates are high, and merging parties show low correlation in usage, efficiencies can be earned through pooling capacity to alleviate high costs among one merging party.[37] Additionally, the model suggests that a major driver of efficiencies is cost asymmetry, which results in variation in occupancy rates across firms and enables reallocation of capacity utilization post-merger.

When examining welfare changes within MSA over time, in 7 of the 8 markets (all except Kansas City, MO) consumers are benefited by the merger on at least one day of the year: additionally, there are large periods of high demand in Madison, WI, Milwaukee, WI, and San Antonio, TX where efficiencies outweigh the increase in market power. For example, the highest gain of consumer surplus in San Antonio takes place on March 15, 2017: the day of a major sporting event where hotel-level occupancy rates averaged 92.7% and where firms' overlap was solely in urban areas.[38] Similarly, one of Madison's largest gains in consumer surpluses fell on August 3, 2017, where hotel-level occupancy rates averaged 95.8%.[39]

An interpretation of consumer harm being minimized during periods of high occupancy is that the efficiency gains which relax the relationship between cost and occupancy rates are most apparent during times when a large firm would otherwise have the most ability to raise prices. Figure 6

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[36]Densities of the changes in prices, occupancy, average costs, and markups are displayed in Appendix Figure 11.

[37]Appendix Figure 8 displays graphs of weekly changes in consumer surplus relative to the pre-merger environment for each of the 8 MSAs.

[38]The San Antonio Spurs played a home game at the AT&T Stadium.

[39]A possible demand shock was the 2017 CrossFit Games, held in Madison, WI from August 3-6, which attracted over 380,000 competitors.

plots the relationship between segment-night-MSA average occupancy and the change in consumer surplus, controlling for MSA-level fixed effects (and hence controlling for the level of market concentration). The merger results in increasing losses to consumer welfare as occupancy—the number of guests impacted by the firms' market power—rises. This trend reaches an inflection point at approximately 70%—the average threshold for convex marginal costs across location nests—and for markets with average occupancy in excess of 90-95%, the merger is in some cases beneficial due to gained efficiencies related to the utilization of nearly-constrained capacity. This result hinges in part on the relative size and overlap of the involved firms: the positive effect is larger in Madison where the firms are relatively small but highly overlapping, and hence the relative size of the efficiency effect is most pronounced, but this effect is not observed in Chicago where city-wide occupancy rates peak at lower levels than smaller markets.[40] However, there are individual days across most markets where consumer surplus rises, suggesting that gains (or losses) are rarely homogeneous.[41]

FIGURE 6: Change in Daily Consumer Surplus for Market Occupancy Levels
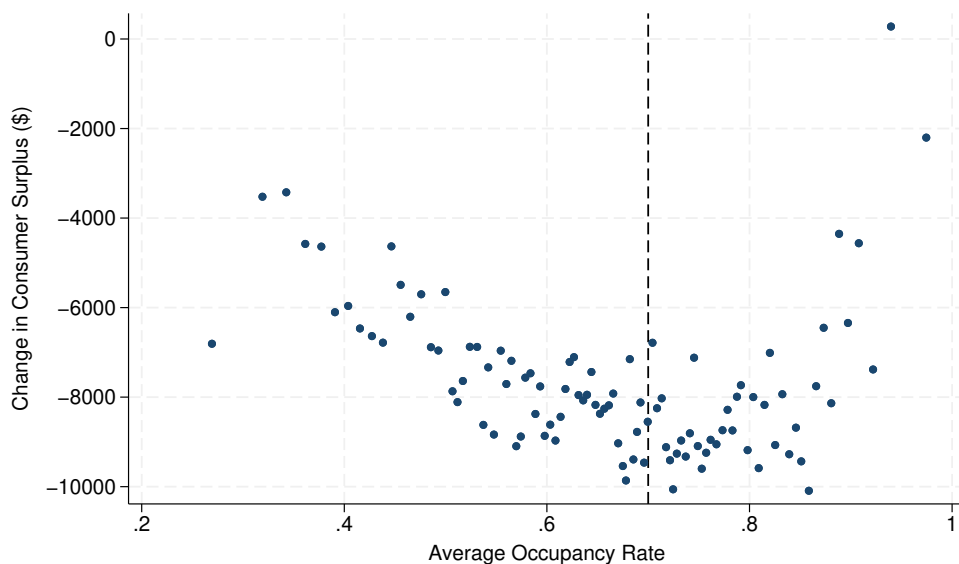
Note: Approximate estimated soft capacity threshold is shown at 70%. Plot is a binned scatterplot which controls for MSA-level fixed effects.

Using a probit model, I test the impact of these market conditions on the probability that the merger is increasing in consumer welfare in a given MSA-night: the pre-merger level and change in HHI (DHHI), the occupancy rates of the merging parties ($o\bar{c}c_{1,2}$), and the correlation in occupancy rates between the merged parties at the segment-month level $\rho_{1,2}^{occ}$ (which in turn selects for segments

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[40]Considering days with at least 90% occupancy, Madison, Milwaukee, and San Antonio see increases in consumer surplus, while other markets see a decrease.

[41]Indianapolis and Kansas City are the two exceptions, having no positive surplus days: Kansas City had the highest naive DHHI for the merger at over 1000.

where firms overlap and controls for seasonal effects which would affect both firms).[42]

$$\mathbb{1}\{\Delta CS > 0\} = \Phi(HHI, \ DHHI, \ \rho_{1,2}^{occ}, \ o\bar{c}c_{1,2}) \tag{15}$$

The results are shown in Table 9. Markets that are more concentrated and face higher increases in concentration are less likely to cause an increase in consumer welfare. Markets where the merging parties' occupancy rates—and hence cost shocks—are more closely correlated are also less likely to improve welfare. On the other hand, markets where the merging parties are at high capacity utilization are more likely to result in non-harmful mergers.

TABLE 9: Probit Regression of Positive Change in Consumer Surplus on Market Conditions

	Coefficient	Std. Err.
HHI (0-10000)	-0.002^{***}	(0.000)
DHHI (0-10000)	-0.006^{***}	(0.000)
$\rho_{1,2}^{occ}$	-1.314^{***}	(0.228)
$o\bar{c}c_{1,2}$	3.480^{***}	(0.727)
Constant	2.313^{***}	(0.751)
N	2,920	

Note: Estimates are at the MSA-night level, averaged across locations for hotels in the upscale, upper upscale, and luxury classes. Standard errors are clustered at the MSA level. $**\ p < 0.05, \ ***p < 0.01$.

Examining the relationship between screening conditions and changes in consumer surplus, mergers that face substantial external competition are least harmful. Additionally, the merger was most often beneficial on days when the merging firms had high occupancy rates but were in periods of low correlation between their rates. Figure 7 displays the changes in consumer surplus for MSA-nights using these screens: when limiting to markets with high occupancy, low correlation, and small merger size, 90 of 2,920 MSA-nights—all in Madison, WI—are identified with a mean nightly change in consumer surplus of $10,884.52 versus an average of $-\$7,649.17$ overall. This suggests that based on the proposed screening criteria only Madison was likely to see overall consumer benefits from the merger, which is supported by the results of the counterfactual simulation.

6.2 Small Acquisitions: Independents and Serial Mergers

The second counterfactual explores the scenario where a large parent company engages in a strategic pattern of the acquisition of small independent rivals. Continued growth among the major hotel chains is to a large degree non-organic, involving acquisitions of smaller rivals as firms compete

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[42]Appendix Figure 12 displays binned scatterplots of the daily change in consumer surplus based on these three conditions.

FIGURE 7: Daily Changes in Consumer Surplus for Screened Markets
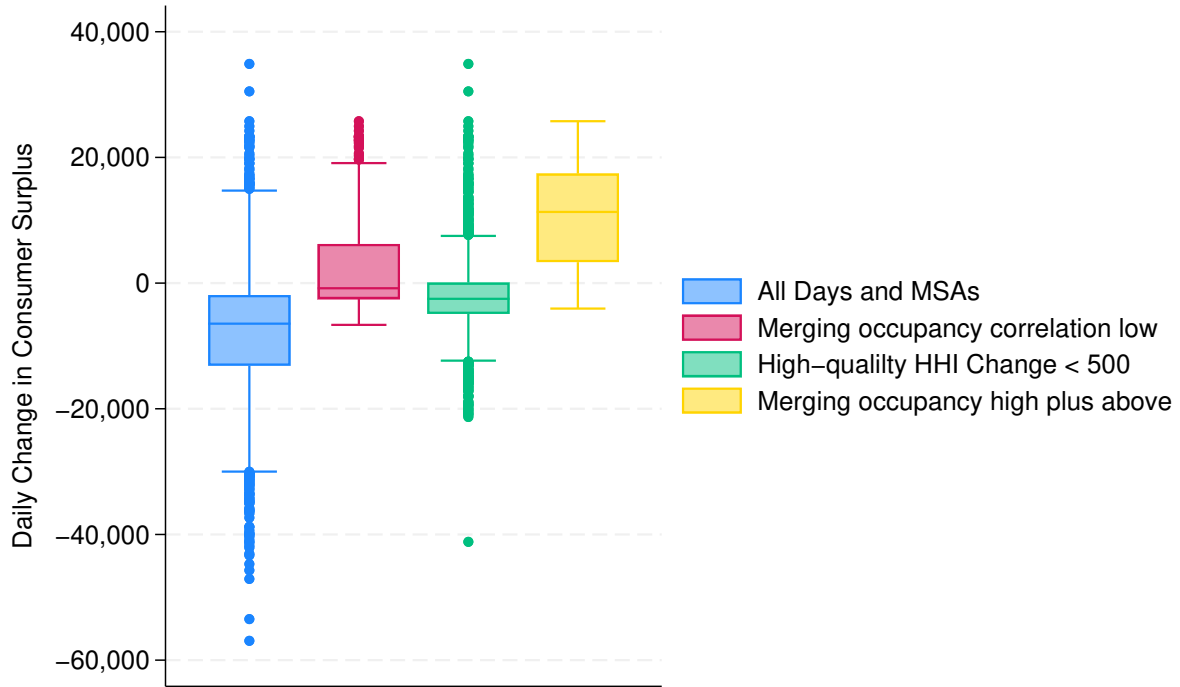
Note: Screening conditions consider monthly segment-level occupancy correlation between merging parties of -0.5 or lower, HHI changes of below 500 when limiting the market definition to upscale, upper upscale, and luxury hotels per location category, and merging firms having occupancy rates of above 85%.

on global growth and brand differentiation. The relevance of serial acquisitions—whose individual actions fall below typical regulatory attention—has been emphasized in both the antitrust literature (Wollman (2021)) and the 2023 Merger Guidelines.[43] While a single small merger has the potential to incorporate efficiencies as a low-cost way of acquiring otherwise-inefficient capacity, a larger pattern assessed as a whole may result in increases in market power which are consumer-harmful. However, in this context there is an alternative possibility: a series of small acquisitions which add up to an enforceable cumulative effect may nevertheless not produce consumer harm if the individual acquisitions are of underutilized capacities such that the acquisitions reduce costs and expand output. As such, a merger screen which treats a series of small acquisitions similarly to a single large acquisition may ignore cumulative cost efficiencies.

I examine how initial firm characteristics drive heterogeneity of effects on costs and consumer welfare by simulating two series of mergers where example large brand-name parent companies

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[43] "Guideline 8: When a Merger is Part of a Series of Multiple Acquisitions, the Agencies May Examine the Whole Series. If an individual transaction is part of a firm's pattern or strategy of multiple acquisitions, the Agencies consider the cumulative effect of the pattern or strategy..."

acquires each of their single-property rivals in Chicago, IL. The primary difference between the firms in each case is their initial size: Firm 1 holds 17.7% of the market share of sold rooms in the high-quality urban market segment while Firm 2 holds 29.4%.[44] Both firms have presence in a range of market segments, but are—in this scenario—aiming to expand their presence in the high-quality urban market segment and so make 13 acquisitions in the downtown upper upscale market segment. The acquisitions are completed sequentially from the smallest rival to largest. Room counts are presented across all market segments, however, I will focus on the high-quality urban market segment where all acquisitions take place as a definition of the local market.

Table 10 summarizes the market concentration throughout the series of mergers. Within the high-quality (upscale, upper upscale, and luxury) urban category, the first acquirer would increase their market share of sales from 17.7% to 30.7%: given the narrow market definition of the high quality urban market, the full sequence would surpass the structural presumption of a merger resulting in more than a 30% market share with a change of HHI of over 100.[45] The second acquirer would increase their market share of sales from 29.4%—near the boundary of the structural presumption—to 42.5%. Hence, while the first firm has room to reasonably expand under thresholds for merger enforcement, the second firm is at the edge of tolerable market concentration and could be seen as attempting to engage in stealth consolidation via small acquisitions. With the exception of the final three mergers, all of the acquisitions fall below the screen of a change in HHI of at least 100.

TABLE 10: Summary Statistics of Hypothetical Sequential Acquisitions

Merger	Case 1			Case 2		
	HHI	DHHI	Share	HHI	DHHI	Share
0	1527.1		17.7	1527.1		29.4
1	1534.3	7.1	17.9	1538.9	11.7	29.6
2	1542.2	7.9	18.1	1551.8	12.9	29.9
3	1550.5	8.2	18.3	1565.1	13.3	30.1
4	1558.6	8.1	18.5	1578.1	13.0	30.3
5	1566.3	7.7	18.7	1590.9	12.8	30.5
6	1588.6	22.3	19.3	1626.9	36.0	31.1
7	1614.3	25.7	20.0	1667.9	41.0	31.8
8	1638.7	24.4	20.6	1706.9	39.0	32.4
9	1687.6	48.9	21.8	1783.5	76.5	33.6
10	1746.9	59.3	23.1	1873.5	90.0	34.9
11	1870.7	123.8	25.8	2059.8	186.3	37.6
12	2002.5	131.8	28.4	2250.3	190.5	40.2
13	2137.8	135.3	30.7	2439.9	189.6	42.5

Note: The market is defined as upscale, upper upscale, and luxury hotels in the Chicago urban market segment. Shares are reported as the average percentage of rooms sold on a daily basis over the year of 2017.

[44] Appendix Figure 13 presents the share of rooms held by the acquirer firms, the 13 properties acquired, and all other rival branded capacity aggregated.

[45] U.S. Department of Justice and Federal Trade Commission (2023).

Table 11 lists the change in cumulative DHHI, average variable costs, and segment prices for the high-quality urban market alongside MSA-level changes in average daily consumer surplus for each of the two simulated merger actions.[46] In the first case, all mergers except the final two are increasing in consumer surplus: average costs across the market fall with each merger except the last, and these cost reductions are passed through to consumers such that prices fall except in the final two mergers. In the second case, all mergers reduce consumer surplus. While costs fall with each merger, it is to a much smaller degree and the reduction is not sufficient to prevent price increases.

The takeaway from these results is that a structural presumption is reasonable in considering the initial market setting for sequential mergers, both in terms of predicting net welfare effects but also anticipating pro-competitive efficiencies. In the first case, where the market share of the acquiring firm was well under the 30% threshold, mergers continually reduced costs and prices. Intervening only after the initial HHI > 1800 and DHHI > 100 would result in blocking the final three mergers in the first case, of which two were harmful. However, if Agencies were to examine this set of mergers as a single action and move to assess—and potentially block—them as a whole, this would be a case of type I error as each individual merger has efficiencies which reduce prices and raise consumer surplus, despite being collectively responsible for DHHI of 343.6 (increasing to 1870.7). In the second case, the theoretical agency should consider the firm's initial market share (29.4%) and assess subsequent acquisitions as a whole to avoid under-enforcement. Mergers do not result in notable decreases in costs, and cost reduction does not constrain rising prices which result in cumulative decreases in consumer surplus. Treating the mergers cumulatively—intervening to block the first 7 mergers once the cumulative DHHI passes 100—would have resulted in better consumer outcomes in this context as each individual merger is harmful.

6.3 Policy Implications

The first counterfactual environment suggests that the Agencies' structural presumption largely holds true, even when considering for merger efficiencies. While average costs fall, pass-through to consumers is rarely sufficient to offset consumer losses (resulting in consumer gains from the merger split). The exceptions, Madison, WI, Milwaukee, WI and—partially—San Antonio, TX, are among the smallest of the mergers by DHHI: the merger in Madison, taking the market definition to be

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[46]I present market-average AVC rather than AVC for the merging firms as the latter is more ambiguous in its interpretation for consumers: the merging firms may reduce costs due to efficiencies, or due to increased oligopoly power which pushes them to inefficiently sell fewer rooms. In the former case, selling the same rooms at a lower cost reduces the overall market AVC. In the latter, competing firms which face higher excess demand sell more rooms at the convex tail of marginal costs, such that AVC is less affected.

TABLE 11: Welfare, Cost, and Price Impacts of Sequential Acquisitions

		Case 1				Case 2		
Merger	C. DHHI	ΔCS	AVC	Price	C. DHHI	ΔCS	AVC	Price
0			153.64	185.30			153.64	185.30
1	7.1	11416.2	153.29	184.74	11.7	-2385.2	153.61	185.33
2	15.1	23265.3	153.02	184.24	24.6	-2446.8	153.57	185.33
3	23.3	32808.7	152.79	183.85	37.9	-2534.2	153.52	185.34
4	31.5	40583.7	152.62	183.54	51.0	-2629.3	153.48	185.35
5	39.1	47141.2	152.48	183.28	63.8	-2697.8	153.44	185.35
6	61.4	64649.8	152.03	182.60	99.8	-3198.5	153.36	185.38
7	87.1	75949.2	151.67	182.19	140.8	-3773.6	153.28	185.40
8	111.6	84372.7	151.36	181.88	179.8	-4403.5	153.20	185.43
9	160.5	105743.1	150.65	181.13	256.3	-5877.1	153.08	185.50
10	219.8	112632.9	150.36	180.91	346.3	-7485.8	152.92	185.58
11	343.6	123036.7	150.02	180.62	532.6	-11146.0	152.72	185.77
12	475.4	122705.4	149.69	180.69	723.2	-15718.0	152.53	185.99
13	610.6	109679.9	149.74	181.20	912.8	-20654.1	152.30	186.24

Note: The market is defined as upscale, upper upscale, and luxury hotels in the Chicago urban market segment. Shares are reported as the average percentage of rooms sold on a daily basis over the year of 2017. Consumer surplus values are reported as average daily changes in USD versus the baseline data.

the MSA-level average across location nests, would result in a change in HHI of only 61.[47] However, heterogeneity in consumer welfare effects over time within MSAs and across MSAs suggests additional detail that can be provided to screen for mergers that may not be consumer harmful.

Given the evidence found, I suggest three criteria under which large mergers should considered. First, at least one of the merging firms should have periods of high capacity utilization (i.e. be capacity constrained), but the firms should display cost asymmetries manifesting in asymmetries in capacity utilization, suggesting potential efficiencies from shifting utilitzation towards lower-cost rooms. Second, the merging firms should demonstrate market overlap where they can earn efficiencies from consolidation over their installed capacity.[48] Third, while the firms should overlap, they must face sufficient competition across other market segments such that their ability to raise markups—across all segments in which they operate—is constrained. This third condition is in part captured by the structural presumption of the Agencies, as well as statements that the merging firms would face sufficient competition from rivals in their relevant quality tiers.[49]

Evidence from the second counterfactual suggests that pre-merger enforcement screens can also aid the detection of when small sequential acquisitions are harmful, but are subject to error in the presence of efficiencies. Firms well under the 30% market share threshold may accrue efficiencies

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[47]Limiting to high-quality location categories, the merger raises HHI by 770 in non-urban/airport locations. This segment is small relative to the full market.

[48]This observation is in line with Bhattacharya et al. (2023), where efficiencies in supply lines can drive price reductions from horizontal mergers.

[49]See European Commission (2016) for the European Commission statement.

which outweigh increases in markups, given the conditions discussed above. This suggests that a series of mergers which results in a cumulative shift that might be challenged could have a positive impact on welfare as each individual piece improves consumer surplus, resulting in a Type I error. By contrast, firms near the threshold of enforcement are likely to see insufficient pass-through of efficiencies such that small, sequential mergers result in continual decreases in consumer welfare. Enforcement in the latter case should be stricter in treating sequential acquisitions as a larger whole and being willing to unwind patterns of acquisitions, limiting the expansion of firms which already hold a potentially dominant position.

7   Conclusion

Continued consolidation in the hotel sector provides an environment for economies of scale over capacity utilization, but also unprecedented market power. This paper studies the impact of capacity constraints on competition, recovering the shape of firms' soft capacity constraints and estimating how the marginal cost function varies based on firm size. Estimates of the structural model allow me to examine the relative impact of merger-specific efficiencies as a pro-competitive offset to market concentration: I show that the presence of the capacity constraint raises marginal costs—here the minimum price acceptable to firms—starting at occupancy rates of 65%-75%, resulting in maximum increases of over $50 for a firm with a single property. This value decreases to $40 for a firm with 4 properties in the same market segment.

This paper then examines two major classes of merger activity: the impact of the Marriott-Starwood merger, and the marginal effects of a series of small hypothetical acquisitions by large national chains. The analysis suggests that merger-specific efficiencies are generally not sufficiently passed through to consumers to result in large mergers having pro-competitive effects, as larger firms have already internalized substantial efficiencies but also have the most ability to raise markups. However, this depends on the degree to which pooling capacity allows for firms to offer rooms at lower cost: when firms are highly capacity constrained but merge with overlapping firms which are not constrained in the same period. Examing the Marriott-Starwood merger, 6 out of 8 studied MSAs saw a fall in consumer surplus, while Madison, WI ($0.88 million) and Milwaukee, WI ($0.13 million) saw predicted increases. Screening markets based on their concentration, occupancy, and correlation in utilization among merging parties identifies Madison as the only likely market for pro-competitive results.

Additionally, pro-competitive results can be found in small acquisitions with minimal effects on market concentration and substantial overlap in operations, where the firm is constrained by com-

petitors from raising markups but can earn efficiencies in joint capacity utilization. In a sequence of small acquisitions by an incumbent brand, mergers had positive (negative) marginal effects on consumer welfare (prices) until concentration rose to near the thresholds specified in the 2023 Merger Guidelines. When the same sequence was performed by a larger brand that held a substantial share ($\approx 30\%$) of the initial share of sales, mergers had negative (positive) marginal effects on consumer surplus (prices). This suggests that firms engaging in stealth consolidation via small acquisitions is a relevant policy issue in the hotel sector, as economies of scale among already-large firms are insufficient to outweigh increases in market power.

An open question is the impact of complexities in the hotel management structure related to the movement towards fully-franchised operations. Brand market power has uncertain net effects on consumers when costs are passed through to franchisees via negotiated rates, but consumers also benefit from economies of scale in the overall brand.[50] I leave this question to future research.

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[50]The potential lack of competition among brands from the perspective of franchises—relating to franchising fees and operational support—was a topic raised in the (abandoned) Choice-Wyndham takeover. See e.g. DePillis (2023).

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Appendix A   Equivalence of Nonlinear Pricing and Convex Costs

In this section, I demonstrate that a model of simple conduct and convex marginal costs recovers the outcomes of constrained nonlinear pricing behavior. The goal is to show that a model of a price-setting hotel, given (a) demand uncertainty and (b) capacity constraints, will produce equilibrium outcomes that ex-post can be decomposed into usual markup assumptions and a nonlinear cost residual reflecting the opportunity cost of selling rooms. Additionally, I model economies of scale via a measure of excess demand spillover that is recaptured within the firm, and show that increasing this internal spillover slackens the recovered soft capacity constraint.

From the Monte Carlo tests, I demonstrate two outcomes. First, I show that raising the probability of stockout via raising the variance of the demand shock results in price rationing at lower occupancy levels, but the effect is nonlinear. This explains why markets (or firms) with different demand volatility may exhibit dispersion in their capacity constraints. Second, I demonstrate that increasing the amount of recaptured excess demand among jointly-owned hotels results in less strict price rationing behavior, starting at the same threshold. The importance of this is in justifying the modeling assumption that a larger firm (that is, a firm controlling more properties in the same market segment) incurs nonlinear cost efficiencies related to its capacity constraint.

A.1   Recovery of Convex Costs

Consider a monopolist hotel j who faces logit demand in period t:

$$u_{jt} = 0.5 - p_{jt} + \xi_t + \epsilon_{jt}, \tag{16}$$

where ξ_t is a random demand shock distributed $N(\mu, v)$, and μ is observed by the hotel but the value of ξ is not. This random shock reflects that while market conditions may be known, hotels face an uncertain flow of demand. The hotel has a capacity constraint $\kappa = 0.4$. The hotel sets a single price that maximizes expected profits in period t. Marginal costs are a constant 0:

$$\Pi_{jt}(p_{jt}; \xi_t) = \max_{p_{jt}} p_{jt} E(\min(s_{jt}(p_{jt}; \xi_t), \kappa))$$
$$= \max_{p_{jt}} p_{jt} \int \min(s_{jt}(p_{jt}), \kappa) \, d\xi \tag{17}$$

All demand $s_{jt} > \kappa$ is forfeited, and hence the hotel will skew prices higher than the unconstrained optimum to avoid the foregone revenue in stockout. The degree which the hotel raises these prices

is based on the risk of stockout, the uncertainty of which is produced by the variance of ξ. By varying the average of the shock, I adjust the probability of stockout $(Pr(s_{jt}(p_{jt}, \xi_t) > \kappa)$. There is a single unique optimal price $p_{jt}(\mu_t)$ at each value of μ.

I simulate the above as follows, using $T = 1000$ and $n = 1000$:

1. Given a draw of μ_t, simulate the integral of ξ via n Halton draws and recover the expected quantity and profit for a starting value of p_{jt}.

2. For a uniform distribution of values $\mu_t = [-2, 2]$, solve for the expected profit-maximizing prices $p_{jt}(\mu_t)$, then determine quantities $s_{jt}(p_{jt})$ given $\xi_t = \mu_t$. As there is a unique $p(\mu)$ for each value of μ, this latter simplification ensures that there is a one-to-one mapping of occupancy to prices.

3. Using the known demand system and observed equilibrium quantities, calculate the ex-post markups $\Omega = - \left(\frac{\partial s_{jt}(p_{jt})}{\partial p_{jt}} \right)^{-1} s_{jt}(p_{jt})$ and recover "as if" marginal costs $\hat{c} = p_{jt} - \Omega$.

4. Compare the recovered $\hat{c}$ to the true marginal cost of 0.

Figure 1 presents the outcome of the monopolist's simulation for $v = \{0.1, 0.2\}$. When the risk of stockout is effectively zero, expected quantities are a distribution of interior solutions, and so the profit-maximizing price is equivalent to the unconstrained problem's solution. In this case, the recovered marginal costs are accurate as we precisely know the demand system. However, as the risk of stockout increases, the hotel's expected quantities include cases where rationing quantity against high demand is optimal. The demand system is misspecified in these cases, and so the recovered marginal cost values are greater than the truth. The residual values $\zeta = \hat{c} - c > 0$ are increasing in occupancy, as the hotel rations its capacity more strictly as it approaches full capacity. Furthermore, as the probability of stockout at any given μ increases in v, the rationing threshold—the level of occupancy where nonlinear pricing begins—is lower when v is higher.

While hotel rationing is a black-box process in practice and extremely challenging to estimate via explicit models of capacity-constrained supply, the above suggests that for an estimated demand system $D(p)$ and a capacity constraint $\bar{s}$:

$$\underbrace{p - \left(\frac{\partial D(p)}{\partial p} \right)^{-1} s(p) = \hat{c} =}_{\text{Recovered Marginal Costs}} \underbrace{c}_{\text{True Marginal Cost}} + \underbrace{\zeta \left(\frac{s(p)}{\bar{s}} \right)}_{\text{Residual Value}} \tag{18}$$

which allows for the standard IO toolkit of demand estimation and conduction assumptions to be employed. The right hand side of Equation 18 closely relates to the suggested approximation for

APPENDIX FIGURE 1: Simulated Prices and Recovered Costs (1)
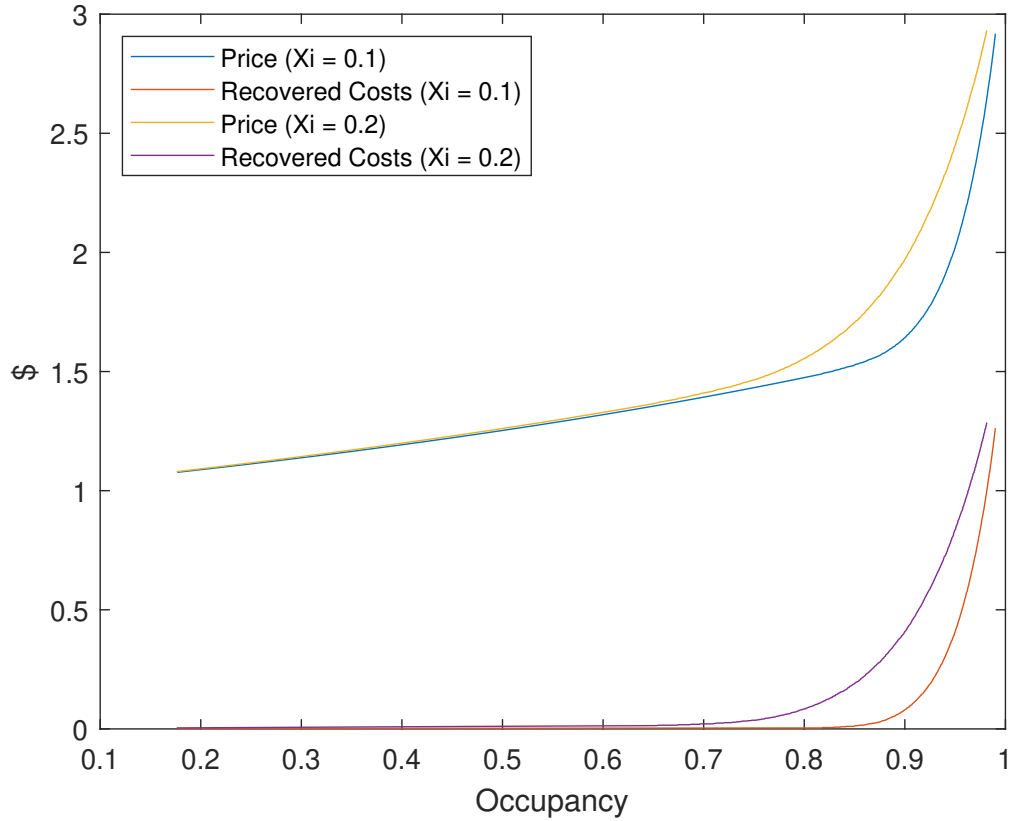
Bertrand-Nash with capacity constraints suggested by Besanko and Doraszelski (2004), and is also captured by kinked curve approaches exhibited by Ryan (2012), Fowlie et al. (2016), and Farronato and Fradkin (2022). The following section looks at how scale affect the functional form of $\zeta(\cdot)$, particularly in how these outcomes can be interpreted as cost efficiencies.

A.2   Demand Spillover and Constraints

When the firm operates multiple hotels, some excess demand at any given hotel can be recaptured by its other properties instead of discarded. Here, I demonstrate that the degree of demand spillover affects the shape of the nonlinear capacity constraint, while holding firm conduct constant. I update the previous example to now contain two hotels with zero marginal costs: Hotel 1 is constrained as in the prior section. Hotel 2 is unconstrained, representing the relatively large mass of remaining rooms operated by the hotel (this may also be read as by the rest of the firm's properties). This assumption will be later relaxed. Consumer utility for each hotel is:

$$u_{1t} = 0.5 - p_{1t} + \xi_t + \epsilon_{1t}$$
$$= V_{1t} + \epsilon_{1t}$$
$$u_{2t} = 1 - p_{2t} + \epsilon_{2t} \tag{19}$$
$$= V_{2t} + \epsilon_{2t}$$

given $\xi_t \sim N(\mu_t, 0.15)$. Profit for the monopolist is determined by setting joint profit-maximizing prices in expectation of ξ.

$$\Pi_t(p_{1t}, p_{2t}; \xi_t) = \max_{p_{1t}, p_{2t}} p_{1t} E(\min(s_{1t}(p_{1t}, p_{2t}; \xi_t), \kappa)) + p_{2t} E(s_{2t}(p_{1t}, p_{2t}; \xi_t)$$
$$= \max_{p_{1t}, p_{2t}} \int p_{1t} \min(s_{1t}(p_{1t}, p_{2t}), \kappa)) + p_{2t} s_{2t}(p_{1t}, p_{2t}) \, d\xi \tag{20}$$

Importantly, there is a spillover rule for excess demand for Hotel 1, where quantities demanded greater than κ are reallocated at logit probabilities to Hotel 2 and the outside option, scaled by a spillover parameter d:

$$s_{2|1,t} = d1(s_{1t} > \kappa)(s_{1t} - \kappa)\frac{\exp(V_{2t})}{1 + \exp(V_{2t})}, \tag{21}$$

and hence:

$$s_{2t} = \frac{\exp(V_2)}{1 + \sum_{j=1,2} \exp(V_j)} + s_{2|1,t} \tag{22}$$

Intuitively, as $d : 0 \to 1$, more revenue is recaptured in the case of stockout and the effects of rationing on Hotel 1's outcomes are diminished. The Monte Carlo simulation is solved as in the prior case, demonstrating this outcome for $d \in \{0, 1\}$. Figure 2 displays these results: at $d = 1$, the steepness of the price rationing is diminished versus $d = 0$, and so too is the recovered convex marginal cost curve. As the probability of facing stockout is the same in each case—the spillover rule does not affect the distribution of ξ—the starting point of the slope is unaffected.

In the above example, I assume that Hotel 1 is massless: Hotel 2 faces no capacity constraints and can infinitely absorb excess demand. The effect of demand spillover in practice is theoretically ambiguous without this assumption, as hotels may also ration in excess to ensure they are able to absorb any expected excess demand from sister hotels. To test the strength of this assumption, I repeat the above scenario where both hotels are "small" in relation to each other, with reciprocal
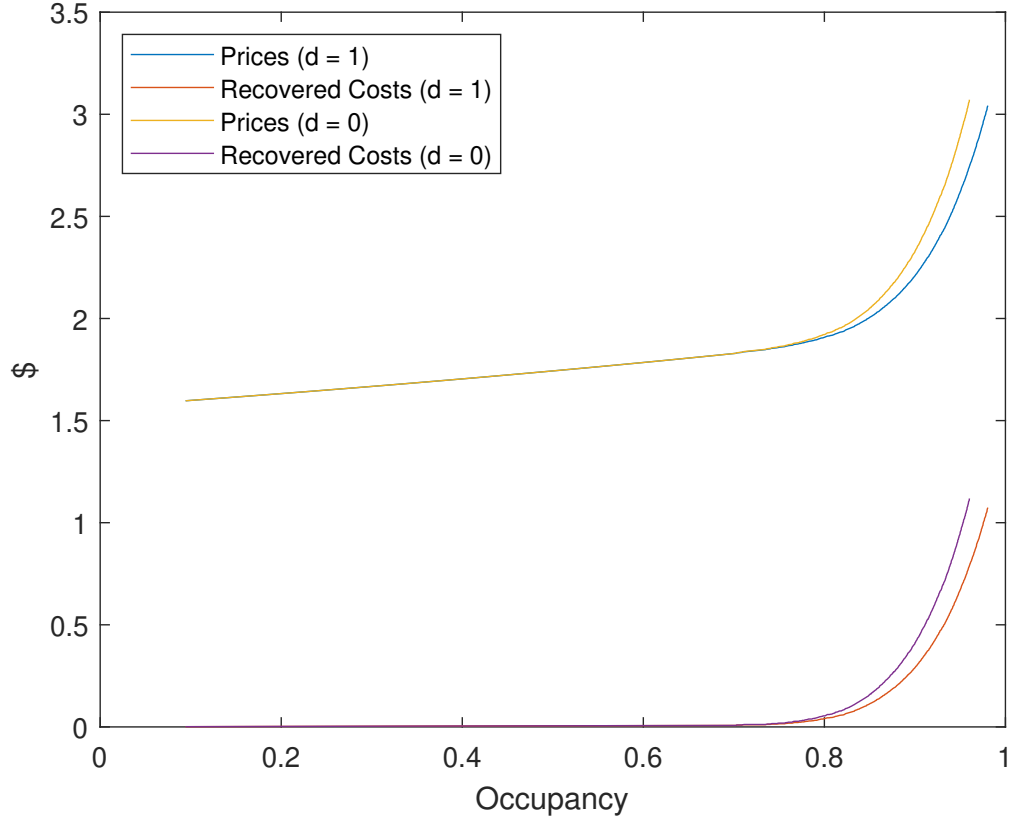
spillovers. Here, ξ_{jt} is multivariate normal and distributed iid $N(\mu_t, 0.15)$, and hotels 1 and 2 face constraints $(\kappa_1, \kappa_2) = (0.25, 0.3)$. Utilities are:

$$
\begin{aligned}
u_{1t} &= 1 - p_{1t} + \xi_{1t} + \epsilon_{1t} \\
&= V_{1t} + \epsilon_{1t} \\
u_{2t} &= 2 - p_{2t} + \xi_{2t} + \epsilon_{2t} \\
&= V_{2t} + \epsilon_{2t}
\end{aligned}
\tag{23}
$$

and the firm's profit-maximization problem is as before but with both firms facing their capacity constraints. The spillover rules are hence defined for each hotel:

$$
s_{j|-j,t} = d1(s_{-j,t} > \kappa_{-j})(s_{-j,t} - \kappa_{-j})\frac{\exp(V_{jt})}{1 + \exp(V_{jt})},
\tag{24}
$$

and shares for each hotel are (dropping the t subscript):

$$s_j(p_j, p_{-j}; \xi) = \frac{\exp(V_j)}{1 + \sum_k \exp(V_k)} + s_{j|-j} \tag{25}$$

Figure 3 shows that the same pattern is observed: moving from zero spillover to logit spillover results in a slackening of the soft capacity constraint.

APPENDIX FIGURE 3: Simulated Prices and Recovered Costs (Large Hotel)
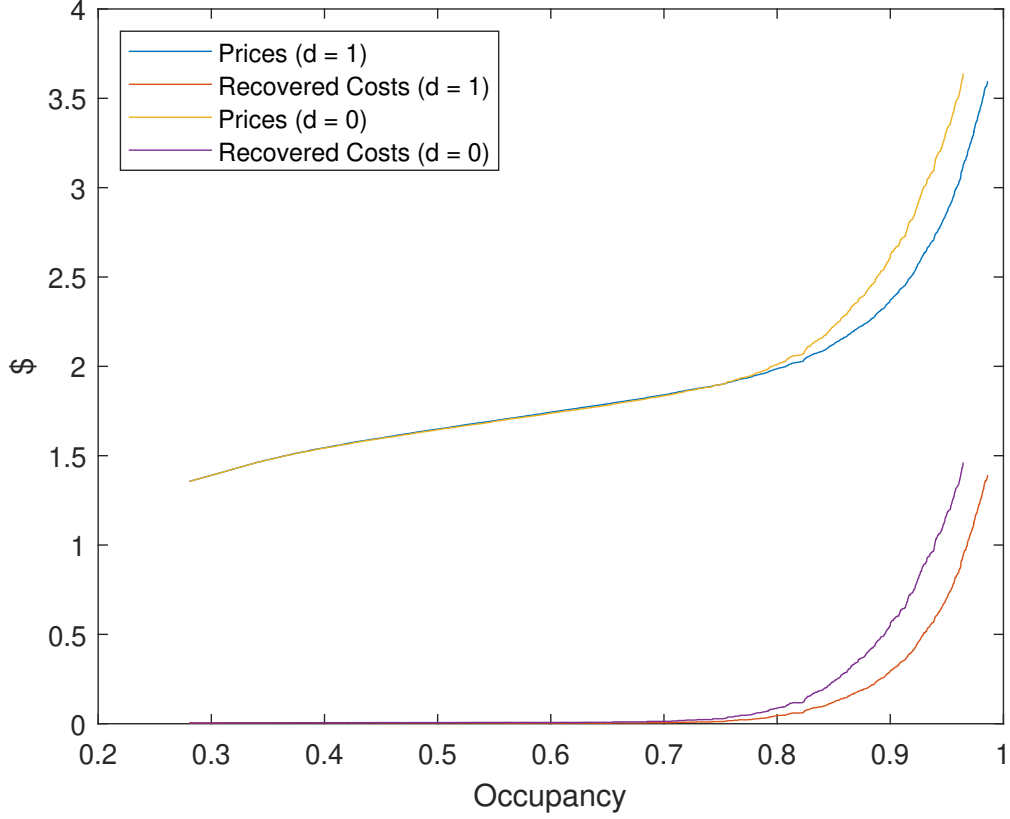
Appendix B   Elasticities and Markups

In this section I use terminology more specific to logit demand. Demand elasticities $\mathcal{E}_{hk} = \frac{\partial s_h}{\partial p_k}\frac{p_k}{s_h}$ in the nested logit case are a $H \times H$ matrix, given segments $h \in H$ with respective nests $\ell(h)$. For segments h and k, the (h, k) element of the elasticity matrix is:

$$\mathcal{E}_{hk} = \frac{\partial s_h}{\partial p_k}\frac{p_k}{s_h} = \begin{cases} \frac{\alpha}{1-\rho}p_h(1-\rho s_{h|\ell(h)}) - (1-\rho)s_h) & \text{if } h = k \\ -\alpha s_k p_k\left(1 + \frac{\rho}{1-\rho}\frac{1}{s_{\ell(h)}}\right) & \text{if } h \neq k \text{ and } \ell(h) = \ell(k) \\ -\alpha s_k p_k & \text{if } h \neq k \text{ and } \ell(h) \neq \ell(k) \end{cases} \tag{26}$$

where s_h denotes the market share of segment h.

Cournot-Nash markups are $\Omega = -\left(\Omega^* \cdot (S_p^{-1})'\right)s$. The ownership matrix Ω^* is a block diagonal matrix determining whether firm-segments h_f and k_f are in the same parent company's set of operated segments $\mathcal{H}_f$. The dimensions of this matrix are hence $\mathcal{H} \times \mathcal{H}$, where each "product" is a firm-segment observation.

$$\Omega^* = \begin{cases} 1 & \text{if } h_f, k_f \in \mathcal{H}_f \\ 0 & \text{otherwise} \end{cases} \tag{27}$$

Taking the linear nested logit demand equation $\log(s_h/s_0) = x_h\beta + \alpha p_h + \rho\log(s_h/s_{\ell(h)})$, the matrix of derivatives $\frac{\partial p_j}{\partial s_k}$ is as follows for the (h_f, k_f) element. The f subscripts are dropped below as the demand system does not differentiate between firms within a segment, and so the derivatives for two firm-segments in the same segment are equal.

$$S_p^{-1} = \frac{\partial p_h}{\partial s_k} = \begin{cases} \frac{1}{\alpha}\left(\frac{(1-\rho)}{s_h} + \frac{\rho}{s_{\ell(h)}} + \frac{1}{s_0}\right) & \text{if } h = k \\ \frac{1}{\alpha}\left(\frac{\rho}{s_{\ell(k)}} + \frac{1}{s_0}\right) & \text{if } h \neq k \text{ and } k \in \ell(j) \\ \frac{1}{\alpha}\left(\frac{1}{s_0}\right) & \text{if } h \neq k \text{ and } k \notin \ell(h) \end{cases} \tag{28}$$

Appendix C Implied Markup and Cost Impacts of Scale

To better visualize the relative magnitudes of the markup and cost efficiency changes, I examine the magnitudes of the changes due to variation in firm size and consolidation. I construct a simple market which contains 16 homogeneous hotels who always sell 99 of 100 rooms and face prices set by the estimated nested logit demand system. All hotels are located in the same segment and nest, with the outside option being contained in a separate nest. As firms are homogenous, there is no impact from consolidation on cost shocks faced by the firms. Firm F_i owns $\{1, \ldots, 8\}$ hotels, and acquires $\{1, \ldots, 8\}$ of the remainder, affecting their marginal costs $mc_i(Q_i)$ and markups $\frac{\partial p}{\partial Q_i}Q_i$. All other hotels are owned independently by firms F_{-i}. This creates 64 merger scenarios, where

the initial concentration and size of the acquisition are varied. The results of this exercise can be read as the comparative heights of the price and marginal cost curve across a range of firm concentrations, assuming firms are otherwise symmetric and no reallocation takes place.

The unilateral effect is estimated as the net change in markups and costs, holding per-hotel quantities constant. Firm quantity $Q_i = 99 \times n(F_i)$: 99 rooms times the number of owned hotels (and hence Q'_i is the new firm-level sum equal to $n(F'_i) \times 99$):

$$\Delta(p)_i = \underbrace{\left(-\frac{\partial p}{\partial Q'_i} Q'_i + \frac{\partial p}{\partial Q_i} Q_i \right)}_{\text{Change in Markups}} + \underbrace{(mc_i(Q'_i) - mc_i(Q_i))}_{\text{Change in Costs}} \tag{29}$$

This approach does not define an equilibrium as quantities do not change: it would be expected that rising markups in the merged body results in reduced quantities and a rival response, or that asymmetries in pre-merger firm costs result in reallocation towards lower marginal cost rooms post-merger. However, it provides an initial screen for the expected price effects of a merger purely due to the estimated scale effects on cost: Miller, Remer, Ryan, and Sheu (2017) discuss how unilateral effects may be valuable—if not accurate—in determining merger outcomes. A positive effect would suggest, ceteris paribus, that the merged firm would reduce quantities and prices would respond upwards.

Figure 4 displays the results, showing that only in the smallest merger environments—those of 2-3 independent firms merging—do the cost efficiencies wholly outweigh changes in markups when ignoring quantity changes or cost shocks. In larger mergers the scale efficiencies are present but insufficient to outweigh the unilateral effects of the merger in driving prices higher. This suggests that efficiencies—when they are observed—are likely driven in part by pooling over asymmetry in utilization.

Appendix D   Counterfactual Details

The counterfactual equilibria involves the updating of the ownership structure, followed by solving the fixed point of the Cournot-Nash system defined by the first-order condition of the supply equation within each MSA-night market n:

$$p_{hn}(\mathbf{Q}_{fn}, \mathbf{Q}_{-fn}) - \Omega_{fhn} - c_{hn} - \gamma_m \log \bar{Q}_{fhn} - \left(\frac{Q_{fhn}}{\phi_\ell \cdot (\sum_{j \in \mathcal{J}_{fn}} \bar{q}_j^r)^{1/r}} \right)^\eta + \mu_{fhn} = 0 \tag{30}$$
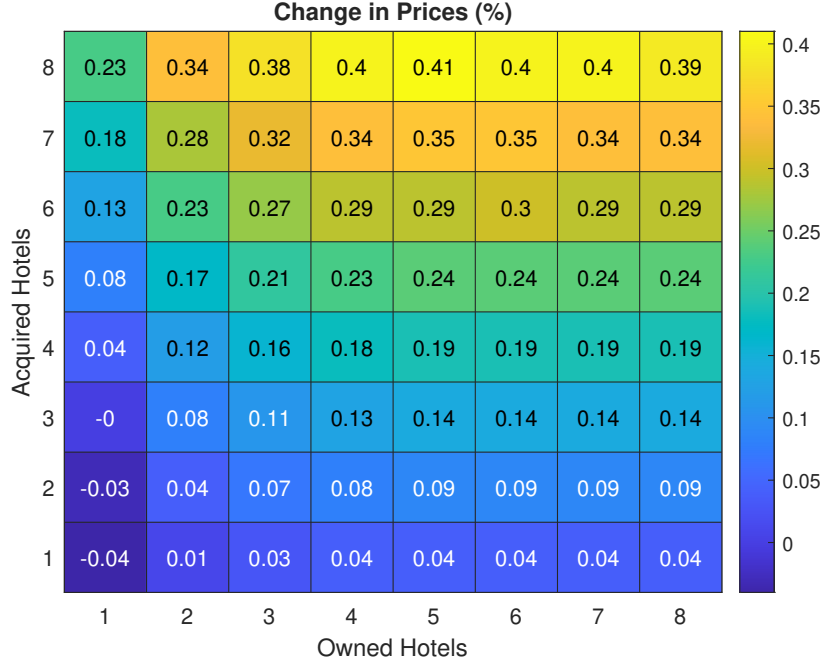
Change in Prices (%)

Note: Presented values record the change in prices represented by Equation 29 as a result of changes in firm size.

given markups $\Omega = - \left(\Omega^* \cdot \frac{\partial p}{\partial Q} \right) Q$, and where the demand system relates prices to segment-level quantity sums as:

$$p_{hn} = \frac{1}{\alpha} \left(\log s_{hn} - \log s_{0n} - x_{hn}\beta_h - \rho \log s_{hn|\ell n} - \xi_{hn} \right) \tag{31}$$

In each counterfactual scenario, hotels are assigned to new firm identities, which results in the number of observations updating as the supply-side model is defined at the firm-segment level. In the first counterfactual, this results in the creation of a new firm-level observation for each market segment where both firms operate, where the original vector of property capacities $\bar{\mathbf{q}}$ is separated into respectively-owned segments.[51] The newly defined firms 1 and 2 in 2017 do not have values for the unobserved cost shock μ_{fhn}: assuming $\tilde{\mu} = E[\mu] = 0$ is problematic as it suggests that the separated firms would face perfectly-correlated cost shocks and hence fill capacity equally, diminishing prospective synergies from the merger. I instead draw cost shocks for the new firms 1 and 2 from a joint normal distribution, such that the correlation between the shocks of the two firms matches that of the same month in the prior year, and the average matches the combined firm's shock in the 2017 data.[52] In the second case where firms are combined, a capacity-weighted

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[51]For the second counterfactual, the combined firm takes a size-weighted average of the unobserved cost shocks.

[52]For September-December of 2017, the correlations from 2015 are used as this was during the merger period of

average of μ_{fhn} is used for the new joint firm.

Appendix E   Additional Tables and Figures

Major Global Hotel Chain	Acquired Brand
Accor	Good Morning Hotels
	Red Roof Inns
Carlson	Park Plaza/Park Inns
Choice Hotels International	Suburban Franchise Systems
	Flag Choice Hotels
Hilton Worldwide	Promus
	Hilton International
Hyatt	Amerisuites
	Summerfield Suites
	LodgeWorks
IHG	InterContinental
	Candlewood
	Kimpton
Marriott International	RitzCarlton
	Renaissance
	Gaylord
	AC
	Delta
	Protea
Starwood	Le Meridien
Wyndham	US Franchise System
	Exel Inn
	Dolce
	Tryp

Note: Table reproduced from Slattery and Gamse (2016) and Roper (2018).

2016.

APPENDIX FIGURE 5: Ratio of Within-segment SD to Mean Prices
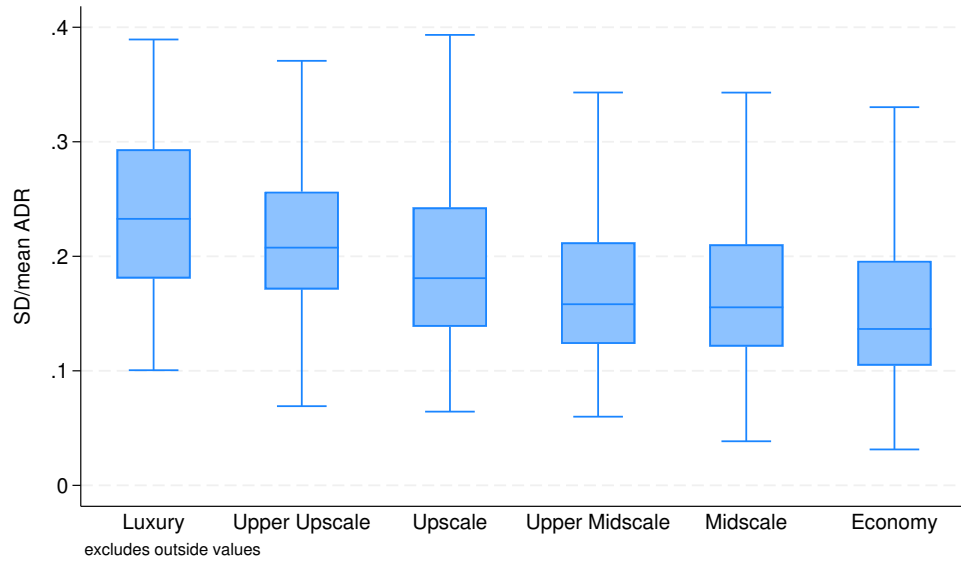
APPENDIX FIGURE 6: Own-Price Elasticities by City
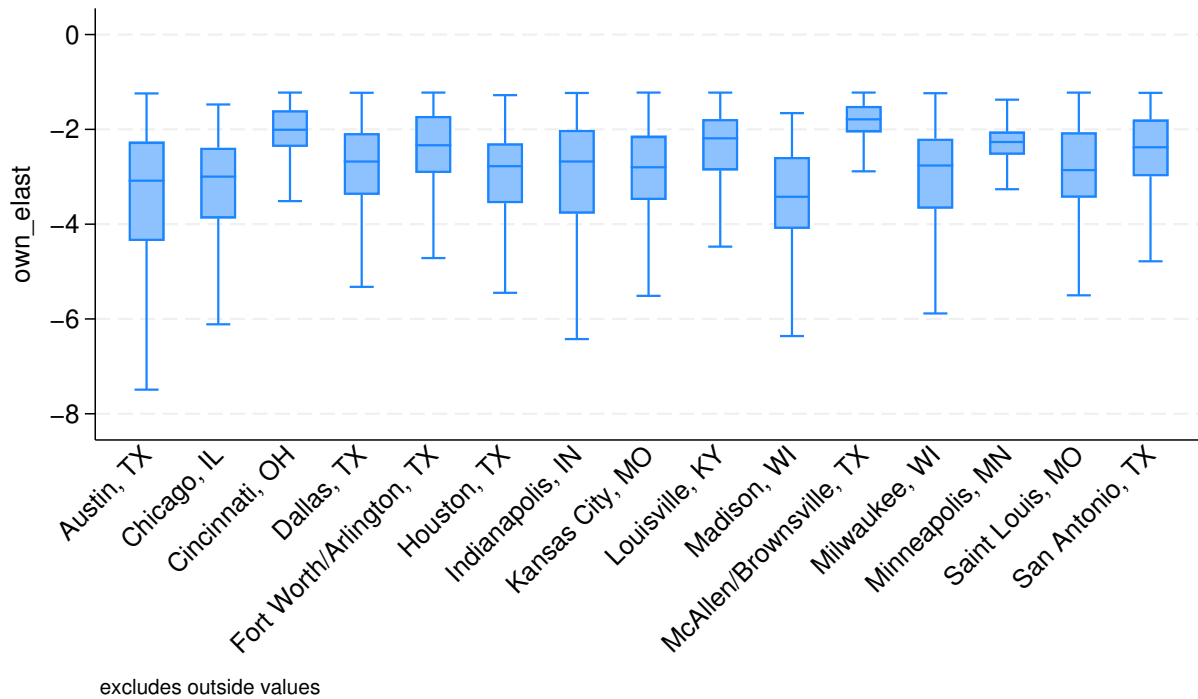
APPENDIX FIGURE 7: Distribution of Estimated Markups and Costs

Kernel density estimate

kernel = epanechnikov, bandwidth = 2.4757
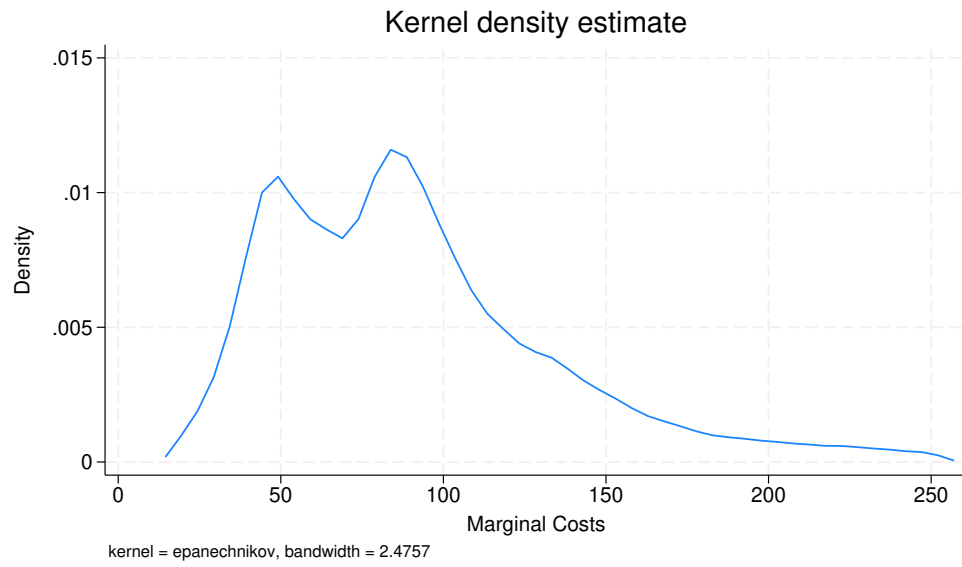
(A) Estimated Marginal Costs

Kernel density estimate

kernel = epanechnikov, bandwidth = 0.0067
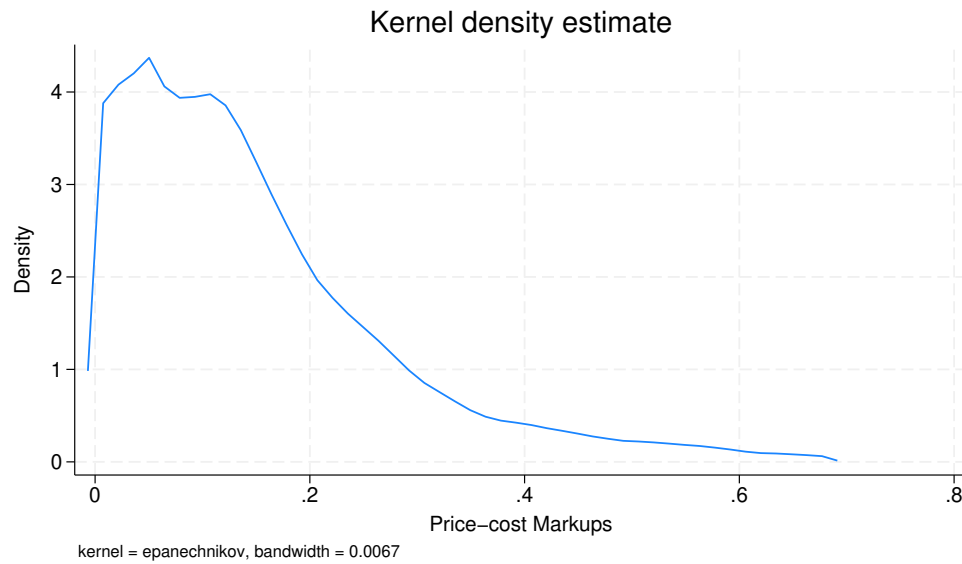
(B) Estimated Markups

Appendix Table 3: Summary Statistics for the Counterfactual Merger Environment

MSA	Location	N	Revenue (Millions/yr)		Rooms		HHI	DHHI
			Room Sales	M Share	Total	M Share		
Chicago, IL	Airport	14	164.7	44.7	4544	44.5	2028	988
Chicago, IL	Urban	51	856.0	30.3	16287	29.3	1092	436
Chicago, IL	Other	64	364.3	36.8	13452	36.7	2756	438
Houston, TX	Airport	8	93.3	48.4	3123	48.8	3148	910
Houston, TX	Urban	23	328.3	36.5	8254	32.1	1570	449
Houston, TX	Other	18	152.8	27.5	5014	31.4	1160	436
Indianapolis, IN	Airport	6	32.5	32.8	1148	28.3	2481	0
Indianapolis, IN	Urban	15	184.4	39.2	4173	40.7	2230	721
Indianapolis, IN	Other	27	133.5	62.0	3843	63.1	3476	939
Kansas City, MO	Airport	7	51.3	51.3	1675	56.7	3900	1143
Kansas City, MO	Urban	13	133.5	63.3	3543	63.3	2819	1880
Kansas City, MO	Other	16	83.1	47.7	2518	45.6	2000	1045
Madison, WI	Urban	8	72.7	0.0	1617	0.0	2207	0
Madison, WI	Other	14	54.6	44.2	1866	42.0	2292	770
Milwaukee, WI	Airport	6	23.0	12.3	850	11.8	2945	0
Milwaukee, WI	Urban	16	142.5	30.2	3539	32.1	1797	343
Milwaukee, WI	Other	18	78.0	35.5	2945	35.3	1889	588
Saint Louis, MO	Airport	10	78.7	47.9	2549	47.1	3682	0
Saint Louis, MO	Urban	26	232.1	37.8	5946	38.1	2012	484
Saint Louis, MO	Other	24	113.4	34.9	3815	33.5	2939	519
San Antonio, TX	Airport	8	44.4	12.6	1774	11.3	3128	0
San Antonio, TX	Urban	12	163.3	40.3	4148	39.2	1582	704
San Antonio, TX	Other	4	28.7	31.8	950	34.2	3620	0

Note: N indicates the mean number of properties in the market segment during 2017. HHI is computed at the location level across luxury, upper upscale, and upscale tiers. Values are averages across 2017 in each displayed segment. As the counterfactual simulates a merger split, the change in HHI (DHHI) values are the differences from post-split to pre-split environments.
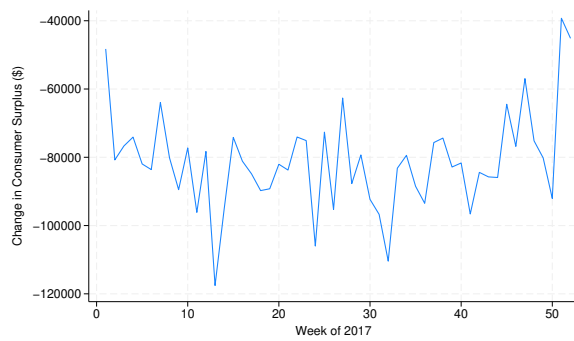
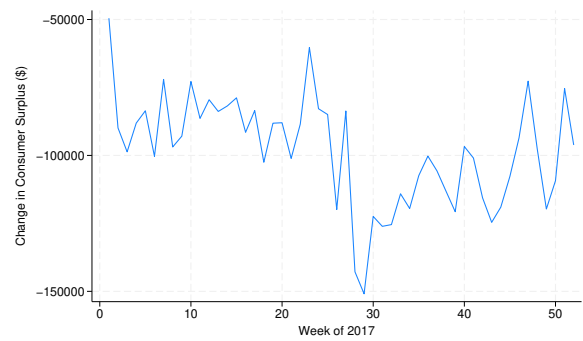APPENDIX FIGURE 8: Change in Weekly Consumer Surplus from Merger Split
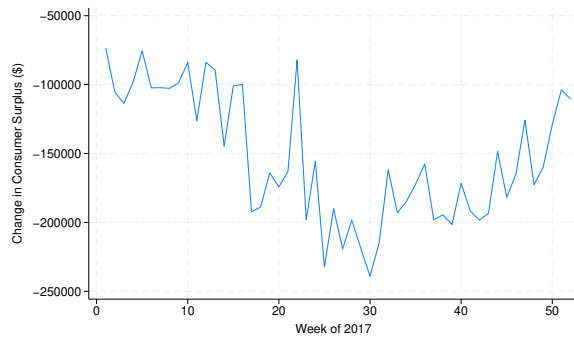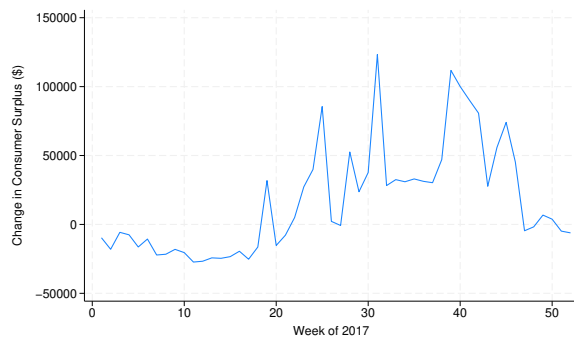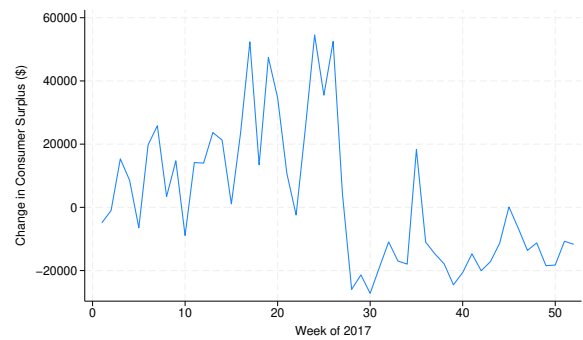

(A) Chicago, IL
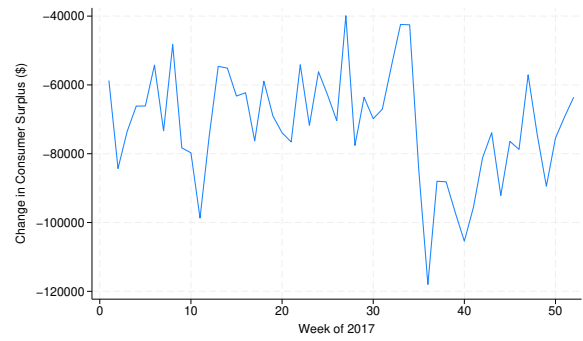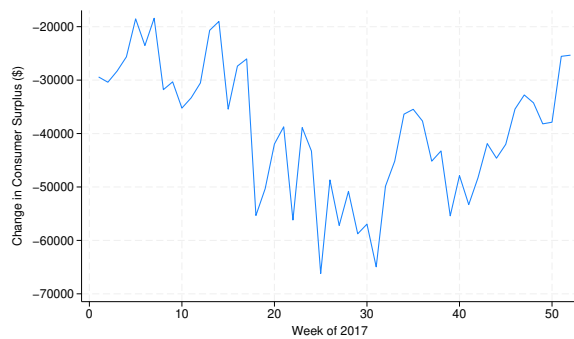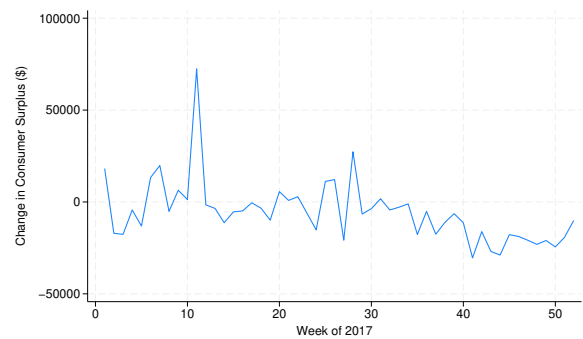
(B) Houston, TX

(C) Indianapolis, IN

(D) Kansas City, MO
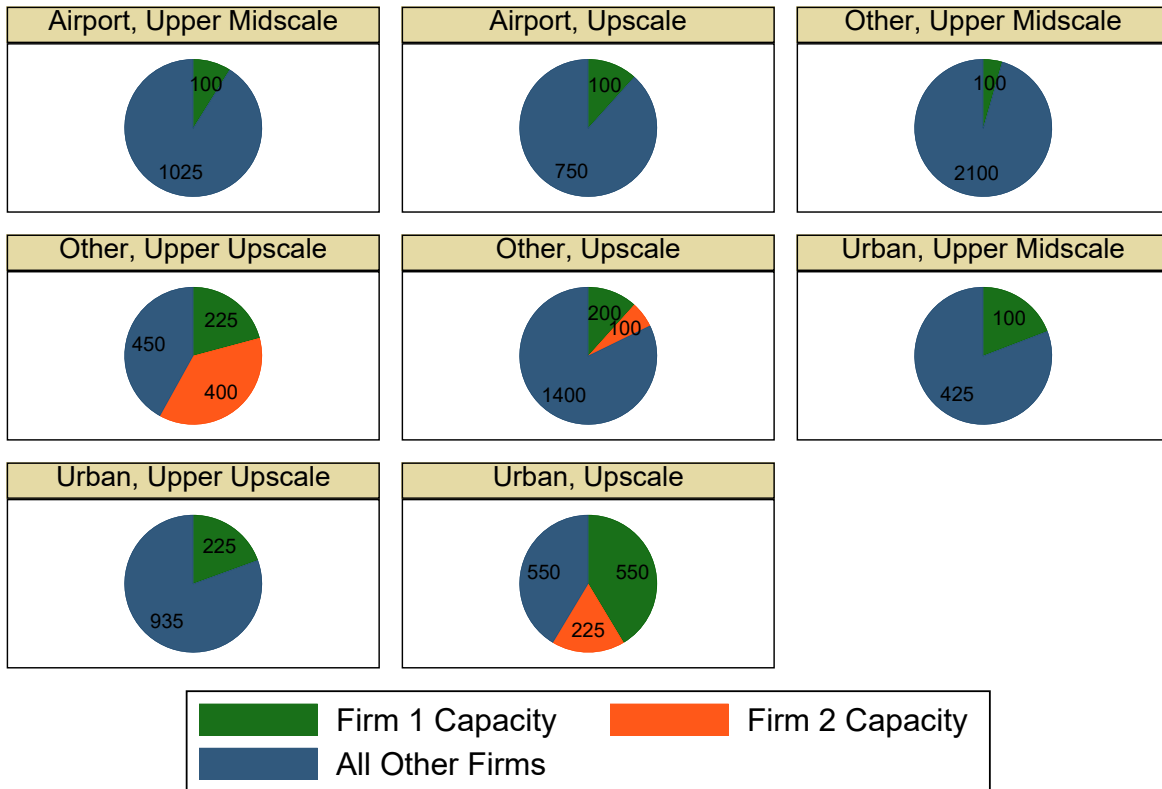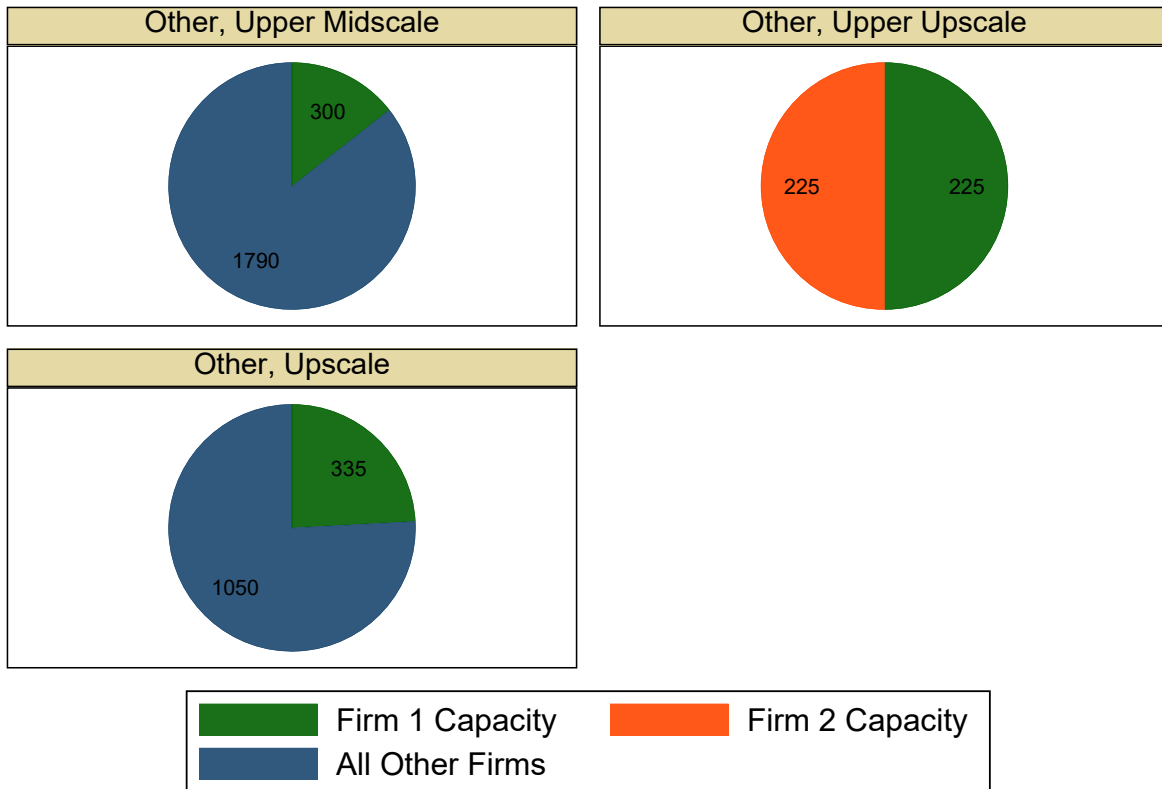
(E) Madison, WI

(F) Milwaukee, WI

(G) St. Louis, MO
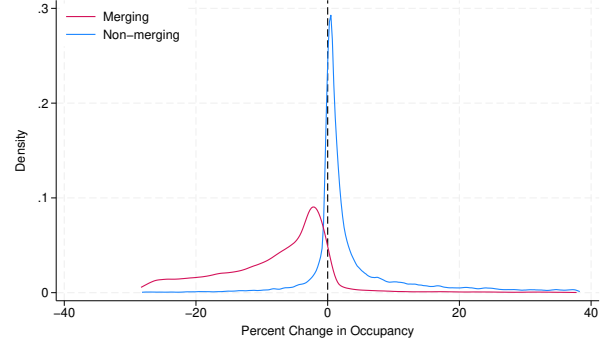
(H) San Antonio, TX

Graphs by loc_type and Class

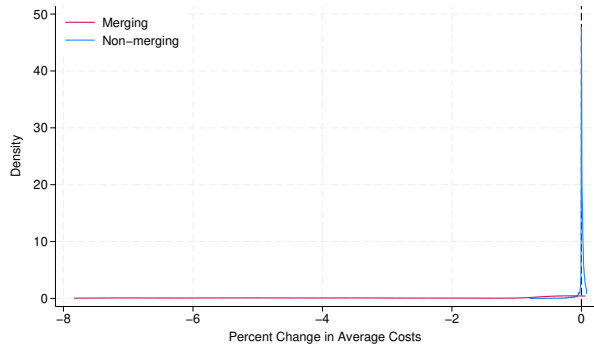Graphs by loc_type and Class

APPENDIX FIGURE 11: MSA-segment-level Merger Effects
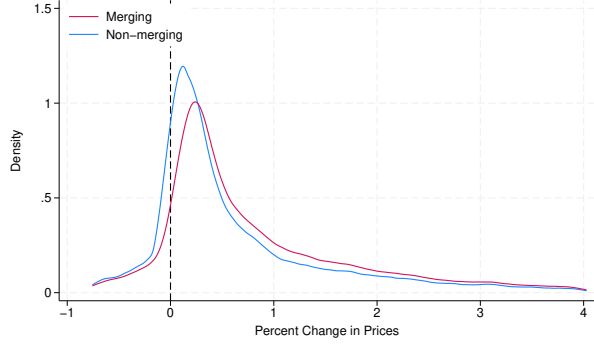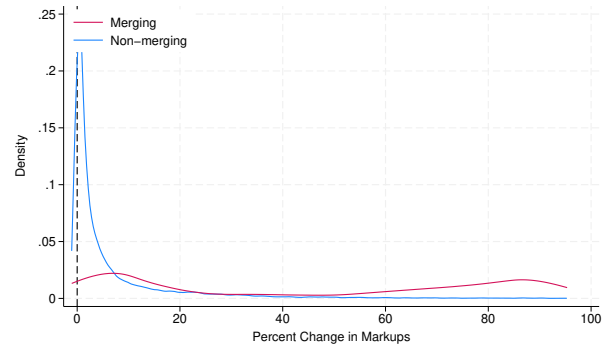

(A) Distribution of price changes
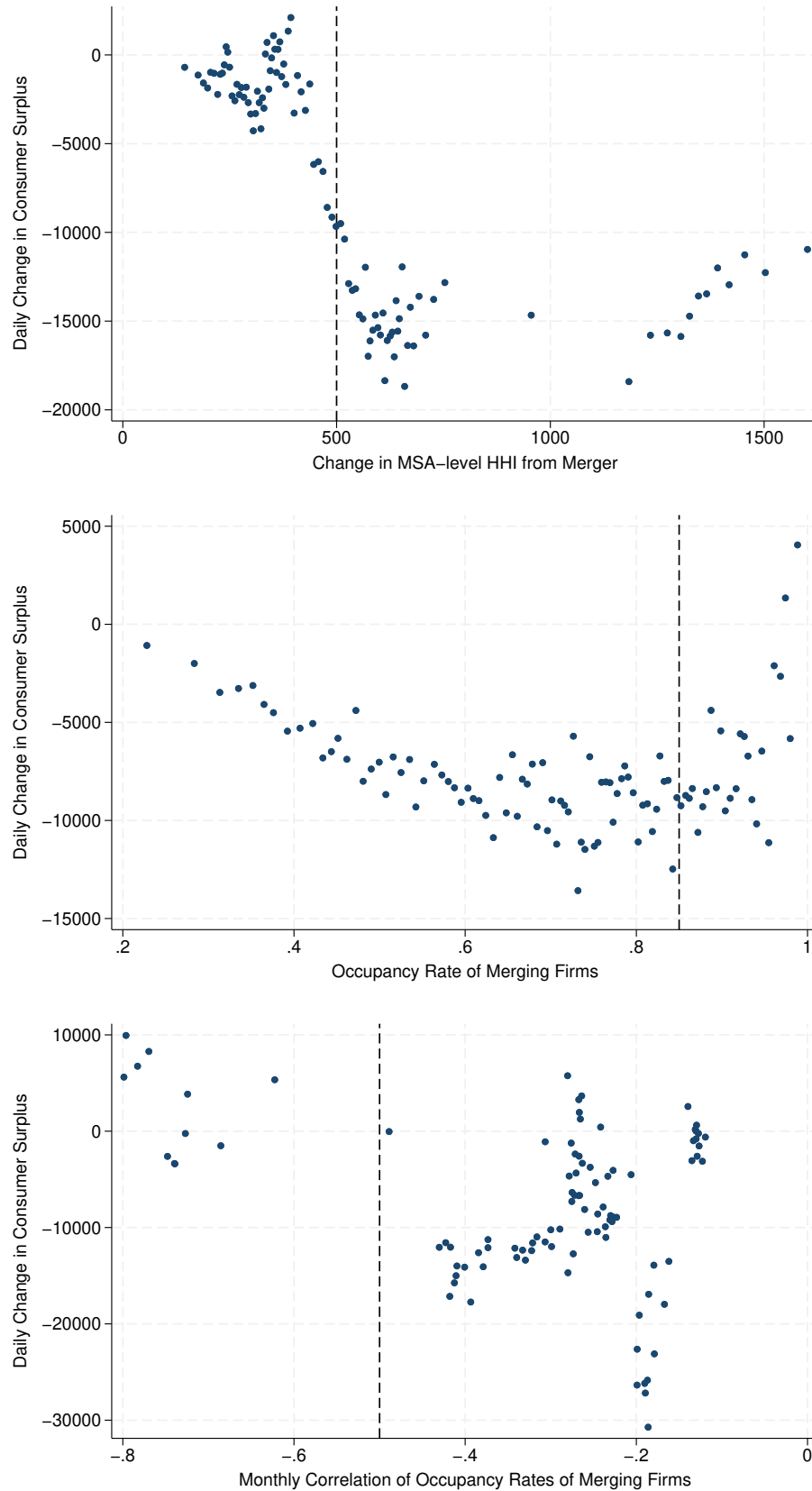

(B) Distribution of occupancy changes

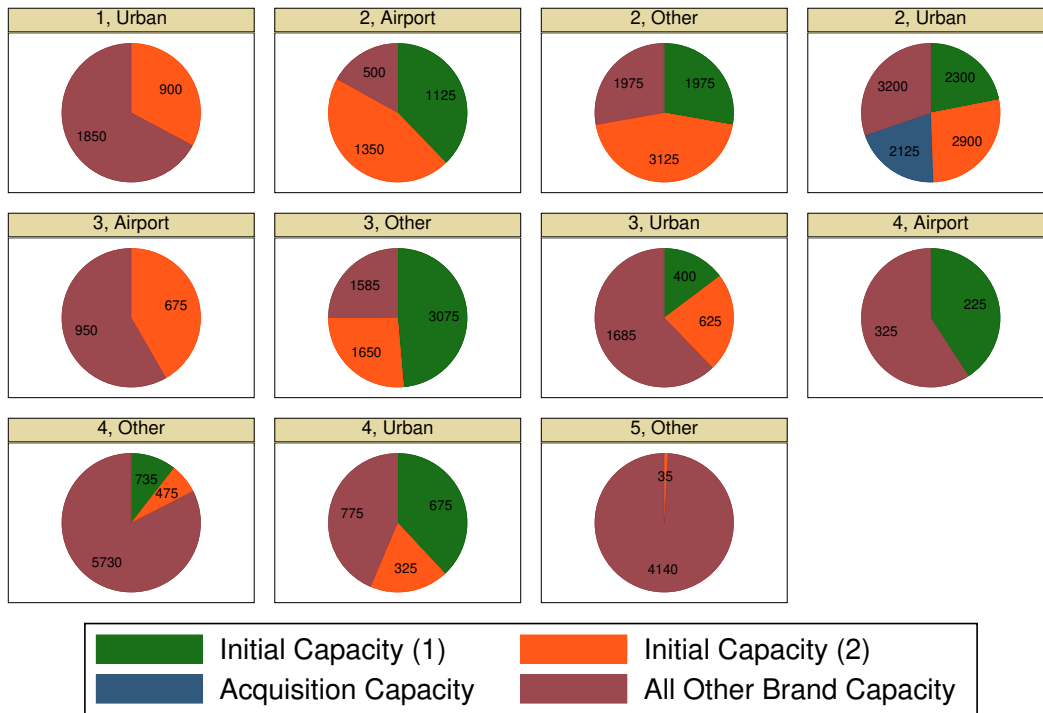(C) Distribution of average cost changes

(D) Distribution of markup changes

Note: Kernel densities are displayed at the MSA-night-segment level for averages of merging and non-merging firms. Outliers beyond the 5th and 95th percentiles are dropped.

APPENDIX FIGURE 12: Change in Consumer Surplus by Various Screening Variables

1, Urban
900
1850

2, Airport
500
1125
1350

2, Other
1975
1975
3125

2, Urban
2300
3200
2125
2900

3, Airport
675
950

3, Other
1585
3075
1650

3, Urban
400
625
1685

4, Airport
225
325

4, Other
735
475
5730

4, Urban
675
775
325

5, Other
35
4140

Initial Capacity (1)   Initial Capacity (2)
Acquisition Capacity   All Other Brand Capacity

Graphs by Class and loc_type

Note: Room counts are portrayed as of January 1st, 2017.