Endogenously determined Quality and Price
In a Two-Sector Competitive Service Market
With an Application to Down-Hill Skiing

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1. Introduction

Increases in real prices and the absence of market entry are integral parts of the definition of a barrier to entry (Carlton, 2004). In addition, there is an extensive game-theoretic literature demonstrating that incumbents can limit entry by preemptive increases in capacity coupled with a credible threat to expand production and reduce price to unprofitable levels. Examples include Lyons (1986), Barham and Ware (1993), Stehmann (1992), and Basu and Singh (1990). This literature, however, does not make a distinction between service capacity and capacity used to produce goods. As a result, it cannot explain increases in both capacity and real prices by incumbents given static demand without resorting to an argument based on market power.

Traditional competitive models imply that excess capacity should result in a reduction in price and, thus, do not provide an alternative explanation. In this paper I show that persistent increases in incumbent capacity and real prices over time even with static demand can be consistent with the absence of market power in a service market where waiting time is an important dimension of service quality. I present a simple two-sector competitive model of service quality with increases in real income and decreases in transportation costs over time resulting in greater capacity and higher equilibrium real prices even in the absence of economic profits and market power.

While quality can take several forms, my proxies for quality are congestion and waiting time. Congestion and waiting time play important roles in a wide range of service markets, such as retailing, transportation, restaurants, healthcare, and recreational facilities. Although the direct link between service capacity and service quality may be peculiar to the specific service process, these markets have in common the importance that changes in service speed and service capacity
have on the time cost of acquiring it.¹

Skiing provides a particularly good example because of an explicit link between service quality and service capacity. The model in this paper focuses on the effect of lift capacity and skiable acres on what skiers consider two important indicators of the quality of a day of skiing: waiting time in lift lines and congestion on the slopes. For example, both Morey (1984) and Walsh, Miller, and Gilliam (1983) provide evidence from surveys of skiers’ willingness to pay for less congestion in lift lines and on the slope.² Recent work by Mulligan and Llinares (2003) shows that the connection between capacity and service quality is especially important in explaining why time-saving technology embodied in new lift capacity follows a diffusion pattern that is distinctly different from that of innovations that lower production costs.

Section 2 reviews the theoretical and empirical literature linking increased capacity and prices by incumbents to entry deterrence, while Section 3 provides background information for the U.S. downhill ski industry. Section 4 presents the two-sector competitive model of quality with implications consistent with the facts presented in Section 3. The model shows how an increase in lift capacity and real lift ticket prices can be a competitive response to increases in real income and decreases in transportation costs despite static ticket sales. Increases in skier real income and decreases in transportation costs over time result in a shift in skier-days from local to

¹ See Davidson (1988) for an example of a short-run model of a retail market that accounts for consumers’ opportunity cost of time and willingness to pay in order to avoid waiting in line. Davidson’s queuing-theoretic model allows for differences in service speed and quality for two firms each with fixed capacity. While extensively used in the field of operations research, formal queuing-theoretic models have had a limited role in economic modeling [Mulligan (1983, 1986)].

² Morey provides empirical evidence that skiers are willing to pay for relatively more skiable acres at a ski area, while Walsh, Miller, and Gilliam document the separate effects of both waits in the lift line and congestion on the slope in skiers’ willingness to pay for a day of skiing.
national markets and increases in both lift capacity and *real* lift ticket prices at all ski resorts, even given no change in aggregate skier-days per season. Adding heterogeneity of skier preferences to the model leads to a higher proportion of relatively more avid skiers at the national resorts, which charge higher lift ticket prices and offer more rides per skier-day than at local ski resorts. Section 5 contains concluding remarks.

2. Excess capacity and entry deterrence

Geroski (1995) provides empirical evidence of substantial entry barriers across a wide range of industries, while Wilson (1992) offers a detailed survey of strategic models of entry deterrence. In particular, there is an extensive literature suggesting that excess capacity can deter entry and result in higher prices for incumbents as long as the incumbent’s threat to use this capacity to increase production after entry is credible. Carlton summarizes this literature as follows,

“The source of any successful strategic behavior must ultimately be traceable to an asymmetry among firms. What game theory (and the contestability literature) makes clear is that dynamics allow credible commitments to be made when there are sunk costs…For example, building a plant with a large capacity in advance of others may be a way to make a credible commitment to produce large outputs, and this investment may advantage the firm making the investment” (p. 468).

As suggested by Carlton, an empirical test for the effect of excess capacity on entry deterrence implies an asymmetry across entrants and incumbents that accounts for differences in their reactions to exogenous shocks to the market. Taking this approach, Mathis and Koscianski (1997) find that an expansion of capacity by incumbents decreased the probability of entry in the U.S. titanium metal industry. Laboratory experiments by Mason and Nowell (1998) and Mason and Phillips (2000) provide additional support for using excess capacity as an entry-deterrent strategy.
Despite these empirical examples and the large theoretical literature, empirical support for excess capacity as a strategic deterrent to entry is relatively rare. For example, Lieberman (1987) noted that even though his own empirical work showed evidence of significant excess capacity in some industries, “excess capacity entry barriers identified in theory are not very common in practice. While firms in [his] sample held significant excess capacity, most was maintained to accommodate demand variability and investment lumpiness... These findings do not imply that excess capacity cannot deter entry, but rather that its use is both rare and unlikely to be completely effective” (Lieberman, 624).

More recently, Singh, Utton, and Waterson (1998) used questionnaire data from managers of three U.K. industries (food, electrical engineering, and chemicals and pharmaceuticals) to measure the extent of strategic behavior in these industries. They found that excess capacity was among the least reported strategies with 86 percent of respondents indicating that the capacity decision was based on meeting current and future demand and less than 10 percent indicating an interest in using capacity as a deterrent to entry. Their results were similar to those of Smiley (1988) for U.S. industries. Summarizing their results, Singh et al. state, “Compared with other rivalrous actions that we consider later, the use of surplus capacity thus seems relatively unimportant and strategic creation of excess capacity seems very much a minority pursuit” (Singh et al., 237).³ More generally, though, there is also a lack of empirical evidence supporting entry deterrence regardless of type of strategy employed. As recently noted by Dafny (2005), “the empirical literature on entry is rather sparse with most studies documenting competitive responses to investment decisions rather than identifying strategic

³ Asplund (2002) has a model showing that the absence of investment in cost-reducing capacity to deter entry may also be due to risk aversion.
motives for the investments” (Dafny, 516). For specific examples, see Chevalier (1995) and Scott Morton (2000).

On the other hand, the available data for the U.S. skiing industry might imply an anti-competitive motive for increases in incumbents’ capacity. For example, both Dafny’s and Lieberman’s tests for entry deterrence focused on asymmetric increases in incumbent’s capacity that could not be explained by expected increases in market demand. In the U.S. ski industry between 1980 and 2002 incumbents’ lift capacity increased on average by nearly 100 percent while lift ticket prices increased approximately 45 percent in real terms. This occurred despite the fact that the number of skier-days fluctuated between approximately 50 to 55 million per year and there was limited entry into the market.

Mulligan and Llinares offered a partial explanation by arguing that ski resorts adopted faster detachable chairlifts since their introduction in 1982 to differentiate their service relative to that of their local competitors and to attract avid skiers who pay higher lift ticket prices and ski more runs per day. However, ski resorts increased lift capacity by adding both detachable and slower fixed-grip chairlifts during this time period. In addition, although Mulligan and Llinares found empirical support for their hypothesis, they did not provide a complete model of capacity and price determination for the industry. Two earlier theoretical papers concerned with congestion pricing that included lift-ticket pricing as the primary application, Barro and Romer (1987) and Scotchmer (1985), also did not provide complete models of endogenous price and capacity determination.

Barro and Romer modeled a competitive skiing market with fixed lift capacity in order to explain the use of lift ticket prices as opposed to per-ride prices. Despite the maintained assumption of a competitive market, Barro and Romer’s model does not address the issues raised
in this paper, because it is short-run in nature and does not account for skiable acreage constraints or differences between national and local ski markets.

Scotchmer used a two-part tariff model to explain the prevalence of lift-ticket pricing as opposed to a membership fee, such as an annual pass. Scotchmer modeled the ski area as a facility of unit size with congestion an increasing function of the number of people using the shared facility (that is, the slope). In her model exclusive use of annual membership fees would be evidence of monopoly power. She concluded that the prevalence of per-day lift ticket pricing was thus evidence of competitive pricing. Since she made no mention of lift capacity as a constraint, Scotchmer’s model is also unable to account for endogenous changes in lift capacity and price over time in response to changes in the demand for less congestion. She also did not acknowledge that annual passes are purchased primarily by frequent skiers who ski during off-peak times. Besides, since the average number of skier days per skier, including those with annual passes, is only approximately five times per year and skiers do not generally ski at only one ski resort per year, an annual membership fee as a means of extracting consumer surplus is of limited practical relevance.

Section 4 shows that service capacity and real lift ticket prices can be explained by a simple two-sector competitive model that accounts for both acreage and lift capacity constraints. A main advantage of the model is that it can explain increases in real prices and lift capacity without having to resort to a barrier to entry and market power explanation. This approach, thus, has points in common with work by Sutton (1991 and 1998) on endogenous vertical differentiation and persistent market concentration. While Sutton does not explicitly model service capacity, he argues that markets characterized by vertical differentiation may remain concentrated over time despite increases in demand and a lack of long-run equilibrium profits.
Sutton’s main examples were expenditures on research and development and advertising, but, as shown in this paper, his basic approach applies equally well to vertical differentiation due to endogenous investment in service capacity.

The distinguishing feature of this paper, however, is that it links endogenous changes in capacity directly to changes in both quality and price. As Carlton indicates,

“The concept of barriers to entry has been a barrier to economists’ understanding of industrial structure and has misled courts and regulatory agencies repeatedly as they attempt to use the concept in antitrust cases or regulatory proceedings... For example, firms can compete against each other by investing in the development of new products, in the promotion of the product, or in the reduction of costs. Indeed, competition along non-price dimensions can explain why concentration does not necessarily change as industries grow, but instead product quality (or advertising) increases, or costs fall” (pp. 466-467).

3. Background for the U.S. Ski Industry

There have been two important exogenous trends that have affected the market structure of the U.S. ski industry since 1980: sustained decreases in real transportation costs and increases in skier real income. As shown in Table 1, the domestic airfare price per transport mile has fallen steadily in real terms since 1980 providing an incentive for skiers to switch from local/regional markets to national ski resorts. Skiers are among the wealthiest Americans. For example, according to a 1996 survey, average skier household income was more than $80,000 with the share of skier households with income under $50,000 only 27 percent (Cravatta, 1997). By comparison, median U.S. household income was only $35,000 in 1996. Since 1980, the biggest increases in income were received by the upper fifth of the income distribution. In 1980 individuals in the top fifth of household income received 43.7 percent of aggregate income. By 2001 this figure had steadily increased to 50.1 percent, while each of the remaining quintiles experienced a decrease in their share during this time period (U.S. Census Bureau, 2005).

During this time period ski areas raised both real lift ticket prices and lift capacity
although these changes were not uniform across the industry. Table 2 summarizes the changes based on data for lift capacity and skiable acreage for individual ski areas and limited data on skier days. While most ski resorts collect data on skier days, many ski resort owners and state ski associations are reluctant to reveal this information. There are ski resorts in 39 of the states, but the number of skier days per year for specific ski resorts is available only in Colorado, Utah, Washington, New Mexico, Idaho, and Oregon and at the state level for Maine, Vermont, New Hampshire, and California.

Table 2 provides information for specific states and groups of states for changes in lift capacity between 1980 and 2002 along with the percentage of ski areas in the state using peak-load pricing on weekends and holidays, average skier days per skiable acre and lift capacity, the percentage change in real lift ticket prices between 1980 and 2002, and aggregate lift capacity per skiable acre. I follow Morey in defining lift capacity as Vertical Transport Feet per Hour (VTFH), which is the number of persons who can be transported 1,000 vertical feet per hour.\footnote{VTFH equals vertical feet times lift capacity divided by 1,000. Lift capacity as reported by ski resorts is the number of persons who can be transported to the top of the hill per hour. This definition of capacity, however, does not account for the ski resort’s vertical drop when making lift capacity comparisons among different ski resorts.} The most notable differences are between New England states, such as Vermont and New Hampshire, and Rocky Mountain states, such as Colorado, Utah, Idaho, Montana and Wyoming. For example, among these ski resorts, the most lift capacity (VTFH) per skiable acre and skiers per acre are in Vermont. While Vermont ski resorts increased lift capacity on average by 79 percent between 1980 and 2002, lift ticket prices increased only by 43 percent in real terms. By contrast real lift ticket prices increased by 92 percent per ski resort in Utah with lift capacity
increasing by 135 percent.\(^5\)

Note that Table 2 makes no adjustment for the length of the season or the fact that the distribution of skier days is likely to be more uniform throughout the week at the national resorts due to the general absence of peak-load pricing. For example, only 4.2 percent of ski resorts in Colorado varied prices during the week, while 64.7 percent did so in Vermont and 82.4 percent did in New Hampshire. As a result, a higher percentage of the skier days reported in Table 2 were concentrated during weekends and holidays at Eastern ski resorts, while spread out more evenly during the week at the ski resorts in the Rocky Mountain States. These adjustments make the crowding on the slope at peak times even greater at the ski resorts with the largest skier day per acre ratios shown in Table 2. For example, Colorado has a skier day per VTFH ratio comparable to that of Vermont (8.36 versus 8.81), while its average VTFH per acre is less than half that of Vermont (39.5 versus 86.3) and it is more likely to have its skier days spread out more evenly through the week. Its ski season is also generally much longer.

Table 3 reports regression results for 288 ski resorts for which I have complete data on lift-ticket prices and lift capacity showing the effect that potentially skiable acres, average annual snowfall, the resort’s lift capacity in 1980 (VTFH), and the use of peak-load pricing had on the percentage change in real lift ticket prices and chairlift capacity between 1980 and 2002.\(^6\) While one would generally expect peak-load pricing to be endogenous, none of these ski areas changed from uniform pricing to peak-load pricing during this time period. As a result, while the actual

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\(^5\) Ski area specific data are from the 1980 and 2002 editions of Enzel’s *The White Book of Ski Areas* on vertical drop, lift-capacity, skiable acres, and lift ticket prices for United States ski resorts and individual ski resort websites. Information on skier days for the year 2002-2003 came from each state’s trade association.

\(^6\) Following the approach of Mulligan and Llinares, I use actual skiable acreage for the 2005-2006 ski season as a proxy for potentially skiable acres for the lift capacity decisions made for
gap in prices between on-peak and off-peak time periods at any point in time is endogenous, the consistent use of this pricing strategy during this time period can be considered to be a proxy for variation in market demand during the week due to such factors as proximity to relatively larger local or regional population centers.\footnote{The prices used in the regression are nominal prices. Between 1980 and 2002 the Consumer Price Index increased by 118.3 percent.}

Weekend and holiday lift ticket prices increased on average more at ski areas using peak-load pricing, ceteris paribus, as well as at ski areas with relatively larger average annual snowfalls and more skiable acres, however the resort’s initial chairlift capacity in 1980 was not correlated with the change in real lift ticket prices. The only factor correlated with increases in lift capacity was available skiable acres in 2005. Counter to what may be expected, ski resorts using peak-load pricing were not more likely to add chairlift capacity during this time period.\footnote{Although ski resorts with relatively more potential skiable acres and greater levels of annual snowfall are less likely to use peak-load pricing, even a regression including only a constant term and the peak-load pricing variable did not have a statistically significant coefficient for this variable.}

In summary, the data show that real lift ticket prices and lift capacity have increased over time at all ski areas despite relatively static aggregate skier days per season. These increases, however, have not been uniform throughout the industry. Ski areas in the Rockies and Western states, such as Colorado, California, Idaho, and Utah have experienced the largest increases in lift capacity over the past two decades while also increasing their lift ticket prices by more than Eastern and Mid-western ski areas. Ski areas that have increased lift capacity and price relatively less are located in markets characterized by greater congestion on the slopes and longer lift lines despite the use of peak-load pricing at most of these ski resorts. These results

years 1980 to 2002.
suggest that a model of how industry capacity and lift ticket pricing change over time must account for both lift capacity and skiable acreage, as well as for differences in the pricing and capacity decisions of local and destination ski resorts.

4. A Two-Sector Competitive Model of Service Quality

This section presents a two-sector competitive model with two capacity constraints that has an equilibrium consistent with the industry data presented in the previous section. For comparison purposes, I start in Section 4a with a one-sector model with unlimited skiable acreage. Section 4b relaxes these two assumptions and presents the two-sector and two capacity-constraint model. Section 4c adds additional skier heterogeneity to the basic model.

a. A One-Sector Competitive Model with Unlimited Skiable Acreage

Assume that there are $N_t$ skiers who ski at the same time on the same day in year $t$. I assume that skiers allocate themselves equally across identical ski resorts and create lift lines that limit each skier to the same expected number of runs per day. Let $q_{it}$ be the quantity of rides (that is, ski runs) per time period $t$ desired by the $i$th person for $t = 0, \ldots, T$ and $i = 1, \ldots, N$. The $i$th person chooses $q_{it}$ in order to maximize $U_{it} = U_{it}(q_{it}, z_{it})$ subject to $Y_{it} = P_t q_{it} + z_{it} + v_{it}$. $Y_{it}$ is real income, $z_{it}$ is a bundle of goods other than skiing with its price normalized to 1, $P_t$ is the implicit price per ride, and $v_{it}$ is an individual-specific, lump-sum cost of going skiing for a day, such as transportation costs, that is independent of the number of ski runs consumed and is not paid to the ski resort. Each skier has a downward-sloping, income-compensated demand curve for the number of runs per day, $q_{it} = D^i(P_t)$. Assume that this function does not vary across individuals, so that $q_{it} = D^i(P_t)$. A monetary equivalent measure of the gain from skiing is the

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9 This assumption is made for expositional purposes. More generally, skiers could be assumed to ski at different times during the season and at different ski areas distributing themselves across
area under the income-compensated demand curve,

\[ \Phi^i(q) = \int_0^q D^i(q) \, dq. \]

The ith individual chooses to ski if the fixed cost of a day of skiing, \( v_{it} \), plus the lift ticket price, \( P_iD_t^i(P_t) \), is less than the gain from skiing, \( \Phi^i(q) \). Assume further that \( \partial q / \partial Y > 0 \), \( \partial Y_{it} / \partial t > 0 \), \( \partial q / \partial v < 0 \), and \( \partial v_{it} / \partial t < 0 \).

There are \( R_t \) identical ski resorts each with capacity \( X_t \) rides per year \( t \) with aggregate capacity equal to \( X_t R_t \). I assume that the full lift capacity of the ski resort is always in use, so that there are lift lines.\(^{10}\) The ski resort can increase the quality of a day of skiing by increasing lift capacity and skiable acres up to the point where lift lines disappear and skiers are not impeded by congested slopes. Beyond this point any increase in lift capacity or skiable acres has no effect on quality. Ski resorts are assumed to be per-ride price takers, while rides are provided subject to a constant returns to scale cost function, \( C(X_t) \), with \( \partial C(X_t) / \partial X_t = c_t = C(X_t) / X_t \). Let \( \pi_{jt} \) equal the lift ticket price at area \( j \). At each ski area the number of rides per skier (that is, the quality of a day of skiing) is \( q_{jt} \) and equals \( X_t / n_{jt} \), where \( n_{jt} \), the number of skiers at ski area \( j \), equals \( N_t / R_t \). While the decision to go skiing is based on the lift ticket price and an expected number of rides, the marginal price per ride would be zero once the skier is at the ski area and has paid the lift ticket price. However, lift lines and congestion on the slope limit the number of runs.

Now assume further that when \( t \) equals 0, there are \( N \) identical skiers and the number of

\[^{10}\) As a result, I ignore the off-peak time in local markets, which is used primarily by season ticket holders.
skiers is fixed over time. As a result, the model does not determine the number of skiers per year \( t \) but the level of quality provided per skier (that is, \( q_t \)).\(^{11}\) The model isolates the effect of increases in real income and decreases in transportation costs over time on the quality of a day of skiing for \( t > 0 \). Skiers continue to ski each year with ski resorts competing to provide the equilibrium quality demanded by the skiers at time \( t \). Since \( c_t \) is constant in the long run and \( \partial q / \partial Y > 0 \), increases in real income over time increase a skier’s demand for \( q_t \) (i.e., more rides per day and shorter waits in the lift line) and shift out the aggregate demand curve for ski runs per day even with no change in the aggregate number of skiers.

The constant-returns-to-scale assumption makes the number of ski resorts indeterminate in the long run. Without loss of generality, assume that the number of ski resorts remains fixed at \( R \), so that in long-run equilibrium \( q_t = RX_t/N \), \( X_t R = D'(P)N(P) \), and \( P_t \) equals \( c_t \). In other words, \( X_t \) adjusts so that no ski resort makes economic profits and all ski areas provide the same level of quality. In effect the \( N \) skiers are demanding and paying for a higher quality of service resulting from the shorter waits in the lift lines due to the increased lift capacity per skier. As a result, this basic model is a restatement of the standard competitive model with free entry and zero economic profits in long-run equilibrium with price being the implicit per ride price and revenue per skier equal to the lift ticket price. Increases in \( Y_t \) and decreases in \( v_t \) over time increase the aggregate demand for runs per day in the same way as an increase in \( N \), the number of skiers, would in the standard competitive model with a constant-cost industry for a good that remains homogeneous over time.

\(^{11}\) The model thus incorporates the stylized facts of the previous section that the number of skier days per season has remained essentially unchanged since 1980.
b. A Two-Sector Competitive Model of Service Quality with a Binding Acreage Constraint for Local Ski Resorts

I now extend the model of Section 4.a by accounting for local and national sub-sectors and the skiable acreage constraint. Assume that the R resorts consist of L competitive local ski resorts and W competitive national/international resorts. Regardless of their preferences for skiing in the national versus the local market, skiers are not likely to have the same opportunity cost of a day of skiing at a national resort. To account for this difference, I follow Dana (1999), who in his model of airline ticket pricing, assumed a uniform distribution of a fixed number of customers according to their opportunity cost for flying at a preferred time of departure.

All skiers are located in the same place as the local ski resorts with \( v^L_t \) being the identical lump-sum cost of a day of skiing at a local ski resort and \( v^W_{it} \) the lump-sum cost of a day of skiing at a national resort for the \( i \)th skier with \( v^W_{it} > v^L_t \). Otherwise identical skiers differ according to the distribution of their opportunity cost per day of skiing at a national resort, \( v^W_{it} \), relative to \( v^L_t \). Skiers with the lowest opportunity cost of a day of skiing at a national resort ski there and, except for the skier on the margin, earn additional consumer surplus that the competitive national ski areas are unable to extract due the assumption of a competitive national submarket.

Assume further that at \( t \) equal to 0, \( \pi^W_0 > \pi^L_0 \). Although as specified, the model does not determine the relative magnitudes of the lift ticket prices in the national and local markets at \( t \) equal to 0, my objective is explaining how lift ticket prices changed over time due to increases in demand for the number of runs per day per skier regardless of an initial perception of relative quality. Additional differences between \( \pi^W_t \) and \( \pi^L_t \) for \( t > 0 \) are thus due to exogenous changes
Now assume that ski resorts in the national market can increase lift capacity in fixed proportion with skiable acreage at constant returns to scale, but that local ski resorts are constrained by available acreage. As a result, at local ski resorts the increase in demand for the number of runs per day per skier increases the overall demand for lift capacity and shorter lift lines at each ski area, but the number of runs does not increase in the same proportion as lift capacity when skiable acreage is a binding constraint. The additional congestion on the slope mitigates some of the advantages of the increased lift capacity. As a result, \( \frac{\partial C_W}{\partial X_t} = P_W < P_L \) = \( \frac{\partial C_L}{\partial X_t} \). In other words, limits on aggregate skiable terrain result in an increasing cost industry for ski runs per day locally with a relatively higher implicit per-ride price in long-run equilibrium in response to increases in demand. Since \( \frac{\partial C_L}{\partial X_t} > C_L/X_t \), local ski areas either earn economic profits or pay higher Ricardian rents for the use of the land.

While capacity and the level of quality increase at both local and national ski resorts, the increased congestion at local ski resorts increases the proportion of skiers who shift from local to national ski resorts making the increase in lift capacity disproportionately greater at national ski resorts. In long-run equilibrium, competition within each submarket drives profits to zero while the skier on the margin is indifferent between skiing in either the local or national sub-sector. As a result, \( \Phi^L(q^L) - \pi^L_t - v^L_t = \Phi^W(q^W) - \pi^W_t - v^W_t \) for this skier. In other words, the skier on the

\[12\] As specified the model assumes that at \( t \) equal to 0, \( \Phi(q^W) > \Phi(q^L) \) and \( q^W > q^L \). In other words, at time period \( t \) equal to 0 national ski areas already provide higher quality due a greater number of runs per skier per day. One could assume further that skiers value a length-adjusted run (that is, VTFH) at a national ski area by more than the equivalent run at the local ski area due to more interesting runs and scenery or amounts of natural snow, so that \( \Phi^W(q) > \Phi^L(q) \) at all values of \( q \) at any time \( t \) and that the cost of providing an equivalent number of rides per skier is greater in the national market due to the increased cost of creating the more interesting ski runs and/or payment of Ricardian rents for use of land with more attractive characteristics, such as
margin pays a net transportation cost that equals this skier’s perceived valuation of the difference in quality in the two sub-sectors net of the difference in lift ticket prices. Any decrease in relative transportation cost also increases the number of skiers going to the national market and results in an additional increase in aggregate capacity at national resorts.

What may be less intuitive is the effect that an increase in demand for rides has on relative lift-ticket prices. Since local resorts are assumed to be per-ride price takers, the increase in demand increases the implicit price per ride in the local market, $P^L_t$, due to the increase in the marginal cost of a ride, $c^L_t(X_t)$. Since skiers are also receiving more rides per day due to the increase in capacity, lift ticket prices increase. The increased demand per skier in the national market also increases lift ticket prices, but the implicit price per ride remains unchanged due to the constant returns to scale assumption. Assuming that the demand for runs is elastic, lift ticket prices in the national market increase by more than they do in local markets due to the lower relative implicit price per ride and the relative increase in the quality of a day of skiing (that is, more rides per day).$^{13}$

### c. Skier Heterogeneity

The model in Section 4.b focuses on vertical differentiation within each submarket and horizontal differentiation across submarkets. We can introduce additional horizontal differentiation into the model in the form of two different types of skiers: avid and non-avid. Avid skiers have a higher value of $\Phi(q)$ for all $q > 0$ compared to non-avid skiers. Ski areas catering only to avid skiers charge the same price per ride as those catering to non-avid skiers but a higher lift ticket price in proportion to the increase in rides per skier. In other words, ski relatively greater annual natural snowfall (that is, $c^W(X_i) > c^L(X_i)$).

$^{13}$ The assumption of an elastic demand for ski runs implies that $\partial \Phi(q)/\partial q > 0$ at the equilibrium.
resorts catering to avid skiers provide the same aggregate number of runs per day to a smaller number of avid skiers and do not make economic profits in long run equilibrium. Otherwise, a ski resort would have an incentive to change its specialization.

Assuming constant returns to scale in both national and local submarkets, there is nothing in the model that would predict which of the two submarkets would attract relatively more avid skiers. With increasing marginal and average costs in the local market, however, the local ski resorts charge a relatively higher implicit price per ride than at the national resort because of the skiable acreage constraint. As a result, avid skiers have a higher relative preference for the national resort given the lower price per ride and the potential for even more rides per day, resulting in relatively more ski resorts in the national market specializing in avid skiers with even higher lift ticket prices than predicted by the basic model.

5. Conclusion

This paper has illustrated the importance of a more detailed modeling of long-run capacity constraints at congestible facilities. I have shown that while ski resorts are constrained by lift capacity, there is an additional capacity constraint due to available skiable acres that is more pronounced at local ski resorts. Ski resorts with less binding skiable acreage constraints are more likely to increase lift capacity over time in response to increases in the demand for quality. The model implies that increases in lift capacity due to exogenous increases in demand for the number of rides per day (or, equivalently, a reduction in waiting time for each ride) result in higher real lift ticket prices and greater lift capacity even in the absence of an increase in the number of runs per day.

14 In Barro and Romer’s short-run fixed capacity model with identical ski resorts, the market separates spontaneously into two sectors catering to either the avid or non-avid groups. Profitability is the same at the two types of ski resorts with avid skiers paying a higher price per
aggregate number of daily visits. While real lift ticket prices and lift capacity increase in both
national and local markets, the largest increases take place at the national ski resorts.

This paper also argues that more attention should be given in the literature to the link
between capacity and quality when quality is defined by the time needed to acquire the service.
Unlike for industries producing goods, increases in service capacity increase quality and are not
necessarily “excess” or a threat to potential entrants as implicitly assumed in the game-theoretic
literature on entry deterrence. Because of a lack of sufficient data on skier days per ski resort, I
am unable to provide a more formal empirical test of the entry-deterrence hypothesis versus the
competitive alternative proposed here. Instead, the model presented in this paper is offered as a
counterweight to an extensive game-theoretic literature that implicitly views as a strategic tool
for entry deterrence increases in capacity that cannot be explained by increases in aggregate
demand.

While the direct link between quality and capacity may not be as clear as it is in the case
of skiing, increases in real prices and capacity in concentrated service markets are not
necessarily evidence of market power or strategic entry deterrence. Although skiing was chosen
for this paper because of the ability to isolate an important measure of quality, the implications
of the analysis are more general and in the spirit of work by Sutton on persistent market
concentration and endogenous vertical differentiation.
REFERENCES


TABLE 1
DOMESTIC AIRFARES PER MILE FROM 1980 TO 2003 (IN 1978 CENTS)

Source: The Air Transport Association of America, Inc.
TABLE 2

LIFT-TICKET PRICES, CAPACITIES AND LEVELS OF CONGESTION FROM 1980 TO 2002 BY SELECTED STATES

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>202</td>
<td>4.2</td>
<td>8.36</td>
<td>331</td>
<td>72</td>
<td>39.54</td>
</tr>
<tr>
<td>California</td>
<td>145</td>
<td>41.0</td>
<td>5.87</td>
<td>54</td>
<td>49</td>
<td>9.17</td>
</tr>
<tr>
<td>Idaho</td>
<td>136</td>
<td>37.5</td>
<td>4.87</td>
<td>68</td>
<td>64</td>
<td>13.91</td>
</tr>
<tr>
<td>Utah</td>
<td>135</td>
<td>14.3</td>
<td>5.71</td>
<td>127</td>
<td>92</td>
<td>22.25</td>
</tr>
<tr>
<td>New Mex.</td>
<td>97</td>
<td>11.1</td>
<td>6.08</td>
<td>175</td>
<td>40</td>
<td>28.73</td>
</tr>
<tr>
<td>Maine</td>
<td>97</td>
<td>69.2</td>
<td>7.34</td>
<td>368</td>
<td>70</td>
<td>50.06</td>
</tr>
<tr>
<td>Mont/Wy.</td>
<td>96</td>
<td>16.7</td>
<td>8.84</td>
<td>117</td>
<td>60</td>
<td>13.26</td>
</tr>
<tr>
<td>Vermont</td>
<td>70</td>
<td>64.7</td>
<td>8.81</td>
<td>761</td>
<td>43</td>
<td>86.30</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>68</td>
<td>82.4</td>
<td>10.76</td>
<td>707</td>
<td>43</td>
<td>65.69</td>
</tr>
<tr>
<td>Midwest</td>
<td>64</td>
<td>76.3</td>
<td>27.72</td>
<td>828</td>
<td>30</td>
<td>29.87</td>
</tr>
<tr>
<td>NY/RI/MA</td>
<td>26</td>
<td>72.7</td>
<td>18.77</td>
<td>826</td>
<td>32</td>
<td>44.02</td>
</tr>
</tbody>
</table>

<sup>1</sup> VTFH is vertical transport feet per hour: the number of skiers who can be transported 1000 feet per hour.
TABLE 3
Percentage Change in real prices and Lift Capacity between 1980 and 2002
(288 U.S. ski resorts)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Percentage Change Lift-ticket prices (Mean Value: 2.155)</th>
<th>Percentage Change Lift Capacity (Mean Value: 0.939)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Values (Standard Deviation)</td>
<td>Coefficient (Std. Error)</td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td>1.783* (0.101)</td>
</tr>
<tr>
<td>Peak-load pricing</td>
<td>0.530 (0.500)</td>
<td>0.162** (0.092)</td>
</tr>
<tr>
<td>(Yes = 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inches of average</td>
<td>0.182 (0.138)</td>
<td>0.813* (0.402)</td>
</tr>
<tr>
<td>annual snowfall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thousands of</td>
<td>0.579 (0.902)</td>
<td>0.255* (0.820)</td>
</tr>
<tr>
<td>Skiable Acres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift Capacity</td>
<td>8.401 (12.961)</td>
<td>-0.001 (0.005)</td>
</tr>
<tr>
<td>(VTFH) 1980</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-Square</td>
<td></td>
<td>0.140 (0.128)</td>
</tr>
<tr>
<td>(Adjusted R-Square)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at the 5 percent level
** Significant at the 10 percent level