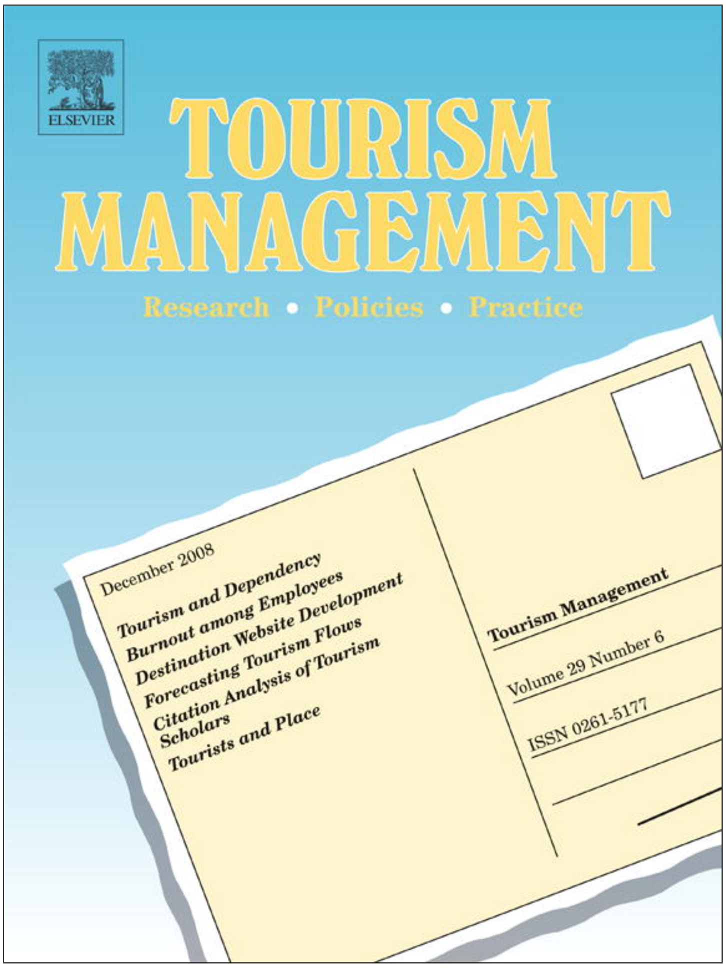
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A hedonic price model for ski lift tickets

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ABSTRACT

Using a unique database of 84 ski resorts and 1520 ski lifts and cable cars in Austria, we investigate the relationship between lift ticket prices for the 2005–2006 season and the ski resorts' characteristics. The results, which were obtained by OLS and robust regression techniques, show that the length of the ski runs, transport capacity (measured as vertical transport metres per hour), share of modern high-speed chairlifts and gondolas, measures of snow conditions (i.e. mean altitude of uphill lift stations, length of ski season, and share of ski runs with artificial snow), and access to neighbouring ski areas covered by the same lift pass all have positive and significant effects on the price of a 1-day lift ticket and a 6-day ski pass. As regards the magnitude, we find that the elasticity of lift tickets with respect to the share of high-speed chairlifts and gondolas is considerably larger than that of the snowmaking capacity. Furthermore, the mean altitude of the uphill lift station and duration of the winter season (both taken as a proxy variables for snow conditions) are more important than the length of the ski runs and total lift capacity (measured as vertical transport metres per hour) in determining the price of a 6-day lift ticket. Given the empirical estimates, we also provide a ranking of the ski resorts according to their quality characteristics.

1. Introduction

The Austrian Alps are one of the most popular ski destinations in Europe. However, Austria's ski resorts differ widely in their characteristics, such as the quality of skiing (e.g. length of ski runs and availability of modern transport facilities), average snowfall, average slope altitude, mountain scenery, distance of the resort from the nearest population centre, and number and quality of accommodations, amenities, and promotional activities. Some ski resorts offer slopes that are 200 km or more in length, while other ski resorts offer only a fraction of that. Many ski resorts have invested heavily in new high-speed lifts and gondola lifts that are often installed at higher altitudes and have a greater lift capacity. Others have better snow cover due to their excellent artificial snowmaking facilities. There are, therefore, many different ski resorts with markedly different qualities. Consequently, it is not surprising that lift ticket prices differ considerably across ski resorts. For example, the price of a 6-day lift pass is 10% higher in Soelden than in Saalbach/Hinterglemm/Leogang, although the two locations offer 150 and 205 km of slopes, respectively. In the 2006/2007 season, some ski resorts, namely Soelden and Ski Arlberg (i.e. St. Anton/Lech/Zuers) broke through the 40€ barrier for 1-day lift tickets. Selecting the best ski resort for one's ski holiday can be difficult sometimes, although the Internet offers high-quality information on the ski resorts' prices and characteristics. Most of this information is provided by the resorts' own websites, but can also be found by way of other sources (see www.bergfex.com). Magazines offering detailed information on ski resorts (such as "*Where to Ski and Snowboard in 2006*" *by Chris Gill*) are also helpful. Since these sources offer detailed information on lift ticket prices and resort quality, ski resorts are expected to face strong competition. As a result, differences in lift ticket prices should be solely due to the quality characteristics and demand factors. In particular, we expect a strong correlation between the price and service quality factors, such as the length of ski runs and number and share of modern high-speed and/or detachable chairlifts. Indeed, the combined market share of the four largest ski resorts, in terms of the number of transports, is only 19.4% for the season 2001/2002, and therefore, it is lower than that of North America at 25% (Hudson, Ritchie, & Timur, 2004).

Hedonic price analysis makes it easier to discern which characteristics are valued by consumers and to what extent. It is frequently used to quantify the effects of housing and neighbourhood characteristics on house prices. For housing prices, empirical studies indicate a strong relationship between price and quality. There are also a number of studies that apply hedonic pricing models to the field of tourism. Applications can be found for package tour prices of Mediterranean summer holiday resorts (e.g. Aguiló, Alegre, & Sard, 2003; Espinet, Saez, Coenders, & Fluiva,

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2003; Papatheodorou, 2002; Thrane, 2005) and for hotel rooms (Cox & Vieth, 2003; Monty & Skidmore, 2003). Relatively little attention has been paid thus far to the price–quality relationship as it concerns ski resorts. A notable exception is Mulligan and Llinares (2003), who studied the price-setting behaviour of 344 US ski resorts from the 1996 to 1997 ski season. The authors find that the ski areas with a higher vertical drop and faster chairlifts (measured as a dummy variable) charge higher lift ticket prices. The population size within 125 miles and the number of competitors also have a positive and statistically significant effect on lift ticket prices.

The aim of the present paper is two-fold. Firstly, it analyses how and to what extent supply-related factors affect lift ticket prices that are measured as daily lift tickets as well as 6-day lift passes. In other words, the aim is to first identify which resort's attributes are valued by skiers, and then to determine the extent to which those specific attributes are valued. Special attention is directed towards the price effects of fast lifts. While in recent years many resorts replaced the old two-seat chairlift and t-bar lifts with modern, fast, and detachable chairlifts and with eight-seat gondola lifts, the value of fast lifts as perceived by the skiers has not yet been investigated. The second aim of the present paper is to provide a ranking of the ski resorts according to their quality characteristics as measured by the predicted prices. The predicted lift ticket prices are then compared to the actual prices in order to find the best price/quality relationship. The most essential characteristics of ski resorts include the total length (in kilometres) of the ski runs, including ski routes; total lift capacity; share of modern high-speed transport facilities; mean altitude of the uphill cable-car and lift stations; and length of season. The hedonic price equations are estimated by utilising OLS and robust regression techniques. In order to enable a more flexible functional form, we also use linear spline functions.[1] To our knowledge, this is the first application of the hedonic price model to ski resorts in a European country using resort-level data. The results are expected to provide a useful basis on which to discuss the magnitude of the effects of resort characteristics on lift ticket prices.

The present paper is structured as follows. Section 2 introduces the empirical model, particularly the specification of the hedonic price model and hypotheses. Section 3 provides the data description, Section 4 presents the empirical results, and Section 5 concludes.

2. Empirical model

2.1. Hedonic price model

In order to investigate the price–quality relationship across ski resorts, we adopt a hedonic price model that was introduced by Rosen (1974). The model assumes that there is a perfectly competitive market with no significant transaction costs. If this is in fact the case, the author shows that the textbook model of perfect competition can be extended to a case where consumers value various attributes in different ways. If all of the attributes are measured correctly, the correct functional form is chosen; if the information is perfect, the outcome of all the independent decisions of the producers and consumers is an exact functional relationship between the price of the quality-differentiated good and the attributes embodied in that good. The model predicts that the attributes that are positively valued will have positive signs in the hedonic price equation. The market for ski destinations is assumed to be in equilibrium if skiers optimise their choice based on the lift ticket prices of alternative ski locations. Under the assumption of no search or information costs, the lift ticket prices of any ski resort can be described as a function of the resort's characteristics. We specify a ski resort's ticket price as a function of a number of characteristics:

$$\ln P_i = \alpha + \beta X_i + \varepsilon_i, \tag{1}$$

where i denotes the ski resort, P_i is the natural logarithm of the price of a 1-day lift ticket (or alternatively, the price of a 6-day lift pass). X_i is a vector of characteristics, and ε_i is white noise. X_i may be measured in logs or levels. The partial derivative of P_i with respect to the characteristics, $\partial P_i/\partial X_i$, refers to the marginal implicit price, which represents the consumer's valuation of (or willingness to pay for) the ski resort's characteristics. For example, the partial derivative of the hedonic price function with respect to the total length of the slopes represents the additional amount that skiers would be willing to pay for an additional kilometre of slopes. Once the regression equation has been estimated, the estimated coefficients $\hat{\beta}$ and $\hat{\alpha}$ can then be used to calculate the logarithm of the predicted price level:

$$\ln \hat{P}_i = \hat{\alpha} + \hat{\beta} X_i + u_i.$$

We then obtain level prices through the exponentiation of the predicted log values. The predicted price level reflects the quality of the ski resort: the higher the predicted lift ticket price, the higher the implicit value of the ski resort. That predicted price can then be compared with the observed price to reveal the ski resorts that are significantly over- or underpriced (Triplett, 2004). If the observed price is higher than the predicted price, the ski resort is considered overpriced in regard to its attributes.

It is well known that the functional form of the hedonic price function has to be determined from the data. Goodman (1978) introduces the use of linear Cox–Box transformation. Halvorsen and Pollakowski (1981) introduce the highly general and flexible quadratic Cox–Box transformation that includes simple functional forms as special cases. Palmquist (2005) suggests that linear Box–Cox and even simple forms (linear and semi-log) are reasonable specifications for the hedonic price model. However, since some explanatory variables, such as the share of slopes covered by artificial snow and the share of high-speed lifts, are characterised by zero-valued observations, we cannot apply the Box–Cox function. Instead, we apply linear spline techniques (see Greene, 2003). In particular, some of the right-hand variables are modelled as partially linear, using a spline function with one knot:

$$\ln P = \beta_0 + \beta_1 x_1(k_i) + \beta_2 x_2(k_2) + \phi Z, \tag{2}$$

where

$$x_1(k_i) = \left\{ \begin{matrix} k & k \leqslant D \\ D & k > D \end{matrix} \right\},$$

where

$$x_2(k_2) = \left\{ \begin{matrix} 0 & k \leqslant D \\ k - D & k > D \end{matrix} \right\}.$$

D denotes the cut-off point or knot. The model is specified by a spline function with two linear parts because of the small sample size.

In order to allow for the neighbourhood effects, one can also re-specify the hedonic model to allow for spatial effects. The spatial-lag model is an appropriate tool when capturing neighbourhood spillover effects (Palmquist, 2005). The idea is that lift ticket prices of neighbouring ski areas influence the lift ticket prices of any given ski resort. Specifically, ceteris paribus, we

[1] The linear spline function allows the parameters to take on different values in different segments of the data.

expect that higher lift ticket prices at a particular ski resort will lead to higher prices at a neighbouring ski resort. In the spatial-lag model, the spatially weighted sum of neighbourhood prices (referred to as the spatial lag) is entered into the specification of the hedonic price equation as an explanatory variable. A general spatial hedonic model incorporating the spatially dependent variable and spatially correlated errors can be written as follows:

$$\ln P_i = \alpha + \rho W \ln P_i + \beta X_i + \varepsilon_i, \quad (3)$$

where $\varepsilon_i = \lambda W \varepsilon_i + v_i$ and W are the weighting matrix, ρ is the spatial lag model, and λ is part of the error term. The spatial weight matrix can be specified as 1 minus the Euclidian distance between ski resorts i and j (weights declining with distance). We test as to whether ρ and λ are equal to zero.

2.2. Explanatory variables

We consider a number of ski resort attributes. Ski resorts differ in several ways, such as average snowfall, lift capacity, average altitude of slopes, their distance from urban centres, the number and quality of accommodations, amenities, and promotional activities (see Ormiston, Gilbert, & Mannig, 1998). Echelberger and Shafer (1970) consider a number of factors that might explain the level of ski days: age of ski area, lift capacity, slope exposure, snowmaking capacity, days of operation, advertising budget, average driving time from population centres to each ski resort, number of ski instructors, and percent of groomed slopes. Using data from 25 US ski resorts, Johnston and Elsner (1972) find that the number of ski days is significantly and positively related to the uphill lift capacity, length of the season, and nearness to other ski areas. These supply-related factors are also likely to affect ski lift ticket prices. In general, supply-related factors can be divided into internal and external factors. Internal factors are those that are entirely within the control of ski resort operators and include the lift capacity and speed of lift facilities, ski run development, piste grooming, and implementation of snowmaking machines. The external factors include additional service offerings (e.g. availability of ski schools, convenient 'ski-in ski-out accommodation'). The literature about the factors explaining ski destination choice also provides insights into the relevant ski resort characteristics. For instance, Klenovsky, Gengler, and Mulvey (1993) suggest that challenging terrain and ski variety play an important role for American skiers regarding their destination choice. Furthermore, crowding and snow conditions also play a role, while ski-slope grooming and proximity to one's home play a minor role. Richards (1996) investigates the pattern and destination determinants of UK skiers, and finds that snow conditions are ranked as the number one factor in skiers' destination choice. The range of difficult runs, variety of terrain, and piste grooming are also important. However, peripheral facilities (i.e. leisure facilities and sightseeing attractions) appear to be relatively insignificant in the actual selection of ski destinations. According to the literature, several indicators of ski resort quality are chosen for this study.

2.3. Length and quality of slopes

One important characteristic of a ski resort is the total length (in kilometres) of ski runs, including ski-routes and the extent of the slopes measured in skiable hectares.[2] It is obvious that the willingness to pay is positively related to the length of the ski runs. The variety of slopes (e.g. tree-lined runs, small glacier, exposed peaks) may also increase the willingness to pay. In addition, the existence of ski runs back to the village, number of off-piste routes, expert trails, and levels of difficulty of the runs could also have an impact on the willingness to pay for lift tickets. Similarly, the availability of a free shuttle service to the lifts from one's accommodation location increases convenience, and thereby the willingness to pay for ski lift tickets. These factors could not be added to the analysis, because quantitative information about these is unavailable. The last consideration is about the longest downhill valley run as an explanatory variable; however, the variable is found to be not significant in any regression and is excluded from the final specifications.

[2] In general, ski areas in Europe are measured by trail length, not by terrain area, as they are in North America.

2.4. Lift capacity

A higher lift capacity obviously is more valuable for skiers because it reduces the time spent in the queue waiting for the ski lift, and makes the resort more attractive. Therefore, we expect lift ticket prices to have a significantly positive correlation with lift capacity. In order to measure lift capacity, we first calculate the vertical transport metres per hour for each lift:

$$\text{VTMH} = \frac{\text{lift capacity in skiers per hour} \times \text{vertical metres rise}}{1000}.$$

This is a measure of lift capacity in passengers per hour multiplied by vertical distance. It measures the number of persons who can be transported uphill at approx. 1000 m/h. For each ski resort, we calculate the sum of the VTMH:

$$\text{LC} = \sum_{j=1}^{J} \text{VTMH}_j,$$

where j denotes the ski lift, regardless of type (this includes surface lifts, fixed and detachable chairlifts, aerial tramways, gondola ropeways such as MGDs, and funitel systems).

2.4.1. Speed and age of lifts

Economic theory suggests that the structure of the transport facilities is also an important determinant for the lift ticket prices and not only for the total lift capacity. Ski lift technology should be convenient and fast in order to transport a large number of skiers while avoiding queues. Many forms of ski lifts, such as T-bars and fixed-grip chairlifts (mostly old double chairlifts) have been replaced by high-speed, high-capacity ski lifts, often with heated seats and covers. Our database enables us to distinguish between highly comfortable high-speed chairlifts/cable cars and less-comfortable fixed chairlifts (such as the old double chairlift), aerial tramways, and surface lifts. The structure of the transport capacity is measured as a share of the lift capacity of modern high-speed lifts and cable cars divided by the total transport capacity:

$$\text{LCQUALITY} = \frac{\sum_{j=1}^{j} \text{VTMH\_HS}_j}{\sum_{j=1}^{j} \text{VTMH}_j},$$

where VTMH_HS includes the transport capacity of high-speed chairlifts, modern gondola ropeways (e.g. monocable gondola detachables or MGDs), and funitel systems, but excludes the transport capacity of surface lifts and fixed-grip chairlifts. We expect a high share of modern chairlifts, LCQUALITY, to have a positive effect on ski lift ticket prices.

Moreover, we calculate for each ski resort the weighted average age of the chairlifts and cable cars, where the weights η_j are the share of each lift in the total lift capacity (measured as VTMH):

$$\text{AVAGE} = \sum_{j=1}^{J} \eta_j \, \text{AGE}_j.$$

2.4.2. Congestion

Congestion occurs when skiers face an increasing number of skiers on the slopes and longer waits in the ski lift queues. Anecdotal evidence suggests that crowds on pistes often occur when uphill lift capacity increases, but the number of pistes remans unchanged. Walsh, Miller, and Gilliam (1983) investigate the impact of slope congestion and congestion in the ski lift queues on the willingness to pay for lift tickets. The authors find that both types of congestion reduce the skiers' skiing satisfaction and lead to a decline of the willingness to pay for ski lift tickets. In order to investigate the link between congestion and lift ticket prices, one can use lift capacity divided by the length of ski runs. An increase in the ratio of the lift capacity to the length of ski runs may lead to a decrease in lift queues but may lead to crowds on the pistes. A low ratio of lift capacity to the length of ski runs may lead to an increase in the number of skiers in lift lines but reduces the number of skiers on the slopes. Therefore, one can expect an inverted u-shaped relationship between the ratio of the lift capacity to the length of slopes and the willingness to pay. In order to account for the possible non-linear relationship, the ratio of the lift capacity to the length of the slopes and its squared term are included in the hedonic price model.

2.4.3. Snow conditions

Snow is the most essential input factor for skiing. Richards (1996) suggests that 60% of all skiers rank snow conditions as the number one factor in selecting a ski destination. Natural snowfall is only one of the several factors that contribute to snow conditions. It is well-known that western and northern areas receive considerably more snow than areas that are deeper in the Alps, as well as the southern and eastern areas. In particular, the Arlberg ski resorts are the first to be hit from north-western winds, and hence, are the snowiest part in Austria. The average snowfall data is unavailable, however, for each of the 84 ski resorts included in the sample. Furthermore, the average slope height is important for snow conditions because snow is less affected by high temperatures and the snow lasts longer at high altitudes. In order to measure the average slope height, we calculate the weighted average of the uphill lift stations for each ski resort, where the weights, η_j, are the share of the capacity of lift j in the resort's total lift capacity, measured as VTMH:

$$\mathrm{ALT} = \sum_{j=1}^{J} \eta_j \, \mathrm{ALTLIFT}_j.$$

Snowmaking can also be an effective means to compensate for a poor natural snow record. The use of snowmaking is measured by the percentage of ski runs with artificial snow. The installation of artificial snowmaking equipment enables skiing with less natural snow, increases the length of the ski season, and leads to even snow coverage throughout the season. Artificial snow-making requires a lot of water, energy, and temperatures that are a few degrees below freezing. Regional parliaments have established restrictions on the duration of the operation of snowmaking facilities. For instance, the operation of snowmaking is only partially allowed in Carinthia and Salzburg after the first of February and March, but there are no restrictions in Styria. The orientation of the slopes (e.g. sunny or facing north) is also important for snow conditions. Finally, the terrain also contributes to the snow conditions. Some high altitude ski areas have rocky terrain, and therefore need good snow cover to be able to operate. Some lower areas need minimal cover. Some of these factors (e.g. the orientation of the slopes, terrain, effectiveness of snowmaking machines, access to glacier sections, and regulations on the duration of snowmaking operation) may be captured by the duration of the ski season. Therefore, we use the duration of the ski season, measured as the number of ski days in operation in the 2005–2006 season, as an indicator of snow cover. One can assume that a longer ski season reflects good snow cover. Resorts with glaciers can typically offer an early season start.

2.5. Effects of joint lift passes that grant access to neighbouring resorts

The attractiveness of ski areas also depends on whether they are connected per ski bus to other ski resorts that are accessible with the same ski pass. For instance, Ski Arlberg offers a lift ticket that is valid at all of its ski locations (Lech/Zuers, St. Anton, St. Christoph, and Stuben), as well as bus rides between the locations. Ski Amadé, Zillertal (Ziller Valley Super Ski Pass), and Kitzbuehel & SkiWelt (Kitzbueheler Alpenpass) also feature interlinked ski areas that are covered by the same pass and connected by a free shuttle bus service. However, they also place restrictions on ticket validity. For instance, unlimited access to the largest Ski Alliance in Austria—Skiverbund Amadé, covering 28 nearby ski resorts in the Salzburg province—is only possible for a ski pass with a minimum duration of three days. The common ski pass for Austria's largest ski resort, SkiWelt & Kitzbuehel (420 km of ski runs), is only available for a minimum of 6 days. The five ski resorts in the Ziller Valley also share a common lift pass that is valid for a minimum of 4 days. Therefore, dummy variables addressing the price effects of interlinked ski resorts are only reasonable for the hedonic equation that determines the prices of 6-day ski passes. In some cases, despite the fact that all of the lifts are in the same province and feature the same joint ski pass, there were no bus rides between the different ski areas and/or long distances between the areas. When this is so, we do not account for the effect of a multi-area ski lift pass. In order to capture the effects of interlinked ski resorts, we include geographical dummy variables for four groups of ski resorts that are part of ski alliances.

2.6. Market concentration

The industrial organisation literature widely agrees that market concentration could have an impact on profitability and allows companies to set the output prices. Using data for 87 tourist hotels in Taiwan, Pan (2005) finds a positive relationship between the market share and profitability. The empirical results for package tour operators indicate that a greater market share leads to an increase in the price of the package holiday Aguiló, Alegre, & Sard, 2003). Theoretical considerations suggest that the market for ski resorts is highly competitive. This is justified by the large number of resorts and the fact that there is no possibility to control the prices of inputs and outputs. Therefore, the market can be characterised by perfect competition or monopolistic competition. In order to provide insight into the level of market concentration, one can calculate the combined market share of the four largest ski resorts (C4 ratio) in terms of the aggregated number of transports for the winter season 2001/2002 of each lift. The C4 ratio based on the number of transports of skiers is 19.3% for the season 2001/2002 (see Table 2). The C4 ratio is lower than that of North America with a ratio of 25% (Hudson et al., 2004). This indicates that there is substantial competition among ski resorts for customers. The four largest ski resorts in terms of the number of transports are Ischgl/Samnaun, Soelden, Skiwelt, and Saalbach/Hinterglemm/Leogang. As an alternative measure of market concentration, the Herfindahl–Hirschman index is calculated. For the season 2001/2000, the index is 0.025, in turn indicating a high degree of competition according to the taxonomy of Martin (1994) and Shepherd (1997).

2.6.1. Proximity to population centres

The resort's distance from population centres may also affect ski lift ticket prices (Echelberger & Shafer, 1970). It is expected that ski lift ticket prices decrease with the distance of the ski resort from where skiers live or stay. Results for the US and Canada indicate that the further a ski resort is from where skiers live or stay, the less likely they are to visit. Distance from metropolitan centres (i.e. Innsbruck, Salzburg, and Vienna in Austria, and Stuttgart and Munich in Germany) can be directly included as an explanatory variable into the model. Since most Austrian ski resorts can be reached from Innsbruck or Salzburg within 2 h, we do not expect that distance is an important determinant for lift ticket prices in this study.

2.7. Events, attractions, and other off-the-slope activities

Hudson et al. (2004) emphasise the role of attractions, such as special winter events, in determining ski destination competitiveness. Indeed, most large ski resorts start the ski season with winter opening festivals. A brief look at the several piste maps indicates that ski resorts often have natural features that facilitate peripheral activities such as mountains especially for hiking, sports, music festivals, and tobogganing. Some resorts have natural ice rinks and thermal spas. However, Richards (1996) suggests that peripheral activities are relatively unimportant in the actual selection of a destination. Thus, we do not account for these factors in the analysis.

2.7.1. Other factors

Finally, there are a number of other characteristics that might be important for the willingness to pay for lift tickets, but they are not easy to measure. Winter sports events, such as the FIS Alpine World Ski Championships and Winter Olympic Games, can have a long-term impact on ski resort infrastructure (e.g. new sports facilities and lift facilities). Some ski resorts received an excellent reputation as World Cup downhill venues. In general, the impact of the previous winter sports cannot be measured based on cross-section data. Since the FIS World Ski championships are often held in ski resorts with a long skiing history, one can use the ski resort's year of foundation as an additional explanatory variable. Furthermore, resorts also differ widely in their character, ranging from traditional villages with an Alpine character vs. purpose-built resorts. Spectacular mountain scenery, such as high peaks and glaciers, may also influence the skiers' choice. Furthermore, the number of ski rentals, availability of traditional mountain restaurants on the slopes, sleeping capacity of the surrounding hotels, and the availability of convenient 'ski-in ski-out accommodation' may also influence the willingness to pay for lift tickets. Another issue is the availability of useful piste maps that should provide practical information on the number and difficulty of the slopes, indications as to whether or not ski routes are avalanche checked, and on the number and quality of lift facilities. However, Molina and Esteban (2006) suggest that the quality of tourism brochures in general do not have a decisive impact on destination choice. Finally, the summer use potential, such as golf and lakes, can strongly influence real estate values; therefore, it can also influence the prices of the input factors for the ski resorts operators, such as land, water, and labour costs.

2.8. Specification of the hedonic price model

The hedonic price model is specified as follows:

$$\ln P_i = \alpha + \beta_1 \ln \mathrm{KM}_i + \beta_2 \ln \mathrm{LC}_i + \beta_3 \,\mathrm{LCQUALITY}_i + \beta_4 \ln \mathrm{ALT}_i + \beta_5 \ln \mathrm{DAYS} + \beta_6 \,\mathrm{ARTSNOW}_i + \beta_7 \ln \mathrm{AVAGE}_i + \delta_m \sum_{j=1}^{M} D_m + u_i,$$

where ln is the natural log. P is the price of a 1-day lift ticket for adults in the 2005–2006 peak season; alternatively, price of a 6-day ski pass for adults in the 2005–2006 peak season (both of which allow for guest card discounts granted to those staying at the resort), KM is the total length of slopes in kilometres, LC is the total vertical lift capacity in persons per hour, LCQUALITY is the share of high-speed chairlifts and gondolas, ALT is the average altitude of peak lift stations (excluding T-bar lifts), DAYS is the days of operation in the 2005–2006 ski season, ARTSNOW is the share of ski runs on artificial snow, AVAGE is the average age of cable cars and chairlifts (excluding T-bar lifts) in years, D_m is the dummy variables for mth associated ski areas that are accessible with a multi-area lift pass without restrictions.

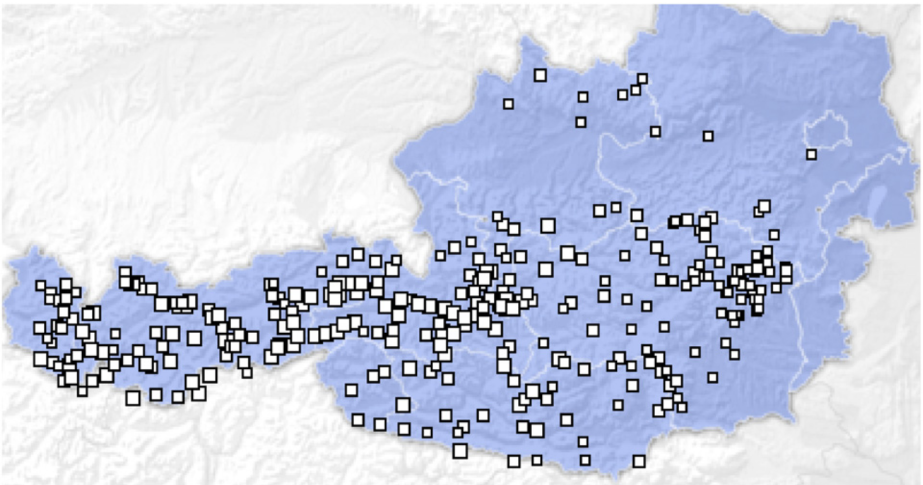
The dependent variable is the natural logarithm of the price of a 1-day lift ticket during peak season (alternatively, the price of 6-day lift pass). The right-hand variables are also in log form, except for the share of ski runs covered by snowmaking machines and the share of high-speed chairlifts and modern cable cars in the lift capacity. The reason is that both the percentage of slopes with artificial snow and the share of high-speed chairlifts include rather few observations with zero values. We can formulate a number of hypotheses. Lift ticket prices increase with the total length of slopes, aggregate lift capacity, share of modern high-speed lifts, and age of the transport facilities. We also expect the price to be positively correlated with the different measures of snow cover (i.e. length of ski season, percentage of slopes with artificial snow, mean altitude of peak lift stations). Finally, we also provide regressions of the hedonic price model, which is extended by various multiplicative interaction terms. As one anonymous reviewer suggests, it is likely that the speed of the lifts may be more valuable for customers visiting ski resorts that have longer ski runs.

3. Data and descriptive statistics

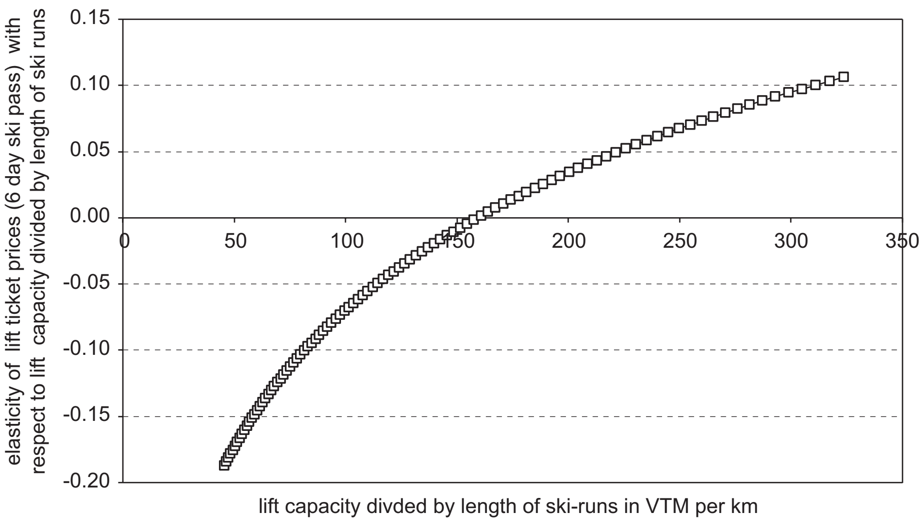
There are approximately 316 ski resorts in Austria as documented in www.bergfex.com. The ski resorts can be found all over the country, but the high-altitude ski resorts are concentrated in the western part of Austria, namely, Tyrol, Salzburg, Vorarlberg, and West Styria (see Graph 1). We select 84 ski resorts, representing 90% of all ski resorts in Austria, featuring a minimum total slope length of approx. 5 km. Our ski area information is obtained from a number of sources. The Association of Austrian Cable Car Operators (2005) and Bergfex (2006) provide data on the length of ski runs in kilometres, ski runs covered with artificial snow, and the number of ski lodges.[3] In order to check the accuracy and reliability of the data, we also retrieved data from the website www.bergfex.com, and from other magazines.[4] These sources also contain information on lift ticket prices. We collected data on two types of lift tickets for adults: the peak-season price of a 1-day lift ticket and of a 6-day

[3] See http://www.seilbahnen.at/winter/seilbahnen/files/winterfibel.pdf; downloaded July 2006:

[4] See ADAC Ski-Atlas 2005/2006, "DSV-Atlas" 2005/2006 and "Der Große Falk Ski Atlas Alpen" 2006.



Graph 1. Geographical concentration of ski resorts. *Note*: number of ski resorts is 316 (Source: www.bergfex.at, downloaded April 2007).



Graph 2. Non-linear relationship between lift capacity per length of ski runs and lift ticket prices. *Note*: the elasticity of lift ticket prices is calculated as $-0.74+2\times0.07\times$ actual values of lift capacity divided by length of ski runs. See Table 6 for the coefficients.

ski pass. In addition, we take into account that some ski resorts offer discounts to guests with an overnight stay at the ski resort. The magazines also contain information on the lengths (in kilometres) of each resort's ski runs, ski routes, and longest run, as well as the percentage of slopes covered by artificial snow.

The information on lift characteristics comes from a variety of sources. The primary source is the cable car database (''Seilbahnstatistik'') referring to the winter season 2001/2002, which is provided by the Austrian Federal Ministry of Transport, Innovation and Technology (2003). This database includes the mountain lift capacity in persons per hour, vertical drop in metres, year of installation, and altitude of the highest lift station. Mountain lift systems include detachable chairlifts (carriers for two, four, six, or eight passengers with a lift capacity of up to 4000 persons/h), fixed-grip chairlifts (carriers for one, two, four, and six), funitel systems (up to 4000 persons/h), MGD gondola lifts (with a lift capacity of up to 3600 persons/h), as well as aerial ropeways and surface lifts, such as T-bars (with lift capacity of up to 1400 persons). The year of installation is not available for surface lifts. Note that the data only refers to the 2001–2002 season. This makes it necessary to supplement this data with information from other sources. In particular, we use data from an Internet site (http://www.lift-world.info/english.php), which provides detailed data on each lift.[5] We carefully checked the data from these various sources to ensure accuracy and reliability. Overall, we found rather few inconsistencies. In total, we collected information on 1524 chairlifts, cable cars, and other lift systems.

Table 1 presents the summary statistics on the variables for the sample used in the subsequent regressions. We report the means, medians, standard deviation, and minimum and maximum values. One-day lift ticket prices for the winter season 2005/2006 range between €24 in Annaberg (in the Lower Austria province) and €39.50 in Lech/Zuers/St. Anton and Soelden. The standard deviation of the lift prices is approx. 3.4, indicating only a small variation in lift ticket prices across ski resorts. The price of 6-day ski passes ranges between €108.50 in Annaberg and €193.50 in Soelden. The average length of ski runs (including ski routes) is 67 km. The average lift capacity is 8941 persons (indicating the capacity to transport 8941 skiers up a mountain at a speed of 1000

[5] In addition, we draw data from the following data sources: ''Seilbahnen, Lifte in Tirol 2004/2005'' (''Cable Cars and Chairlifts in Tyrol'') and ''Seilbahnen, Sessel- und Schlepplifte in Vorarlberg 2005/2006'' (''Cable Cars and Chair- and T-Bar Lifts in Vorarlberg'').

vertical metres per hour). The share of high-speed (detachable) chairlifts and modern gondola lifts, in total lift capacity, is 59%. The mean altitude of peak lift stations (i.e. uphill cable and chairlift terminals) is 1916 m. As expected, the average altitude is highest at the glacier ski resorts (e.g. Pitztaler, at 3001 m; Stubaier, 2812 m; and Soelden, 2707 m). Among the non-glacier ski resorts, this figure is highest at Ischgl/Samnaun at 2518 m, followed by Kuehtai at 2423 m. The weighted average age of the mountain lift systems (excluding surface lifts) is 11.3 years. The mean length of the ski season is 144 days. On average, snowmaking facilities are in place on 61% of the runs. Ischgl and Saalbach/Hinterglemm/Leogang rank number one and two in the share of high-speed lifts. SkiWelt Wilder Kaiser offers the highest lift capacity and the longest slopes (see Table 2). The two Ski Amadé resorts (i.e. Flachau/Wagrain/Alpendorf and Planai/Hochwurzen/Hauser-Kaibling/Reiteralm) have the highest share of slopes with artificial snow. The glacier ski resorts are characterised by high altitude lifts and a long ski season.

Table 3 shows the correlation among the variables. As expected, there is a significant correlation between lift ticket prices and different quality characteristics in most cases. The highest correlation can be observed between the total transport capacity and lift ticket prices. As expected, there are also some high correlation coefficients between the right-hand variables. For instance, the total length of slopes and lift capacity are highly correlated, with a coefficient of 0.88 and a p-value of 0.00. Therefore, we perform an F-test of whether the total length and lift capacity are jointly significant.

4. Estimation results

4.1. Results for the basic hedonic price equation

Table 4 presents the OLS estimates of the log-linear hedonic price equations for 1-day lift tickets (upper panel) as well as for a

Table 1
Descriptive statistics (winter 2005/2006)

	Mean	Median	S.D.	Min	Max
Price of 1-day lift ticket for adults (€)	32.2	31.5	3.4	24.0	39.5
Six-day lift pass for adults (€)	156.2	156.75	18.3	108.5	193.5
Total length of ski runs (km)	67.5	44.0	55.5	8.0	255.0
Lift capacity measured as vertical transport metres in persons per hour divided by 1000	9013	5032	8486	980	38,514
Share of detachable chairlifts, detachable cable cars and funitels (%)	59.7	64.2	19.8	0.00	87.8
Weighted mean altitude of uphill lift stations (m)	1916	1824	385	1170	3008
Length of ski season (days)	144	140	32	110	303
Percentage of slopes with artificial snowmaking facilities (%)	60.8	66.8	29.0	0	100
Average age of lift facilities (in years)	11.3	10.9	4.1	0	23.1
Lift capacity divided by total length of ski runs (in years)	134.5	125.7	53.7	42.4	338.8

Note: The number of observations is 84 (Sources: Cable Cars and Chairlifts database, www.lift-world.info/www.bergfex.com; ski guides and ski magazines and association of Austrian Cable Car Operators).

Table 2
Basic characteristics of the largest ski resorts (ranked by market share)

	Market share (%)[a]	Length of ski runs (km)	Lift capacity[b]	Share of high-speed lifts (%)	Ski runs with artificial snow (%)	Altitude of uphill lift station (m)	No. of days in operation	Age of lift in years[c]
Ischgl/Samnaun Silvretta Arena	6.0	240	31,645	87	33	2519	157	10.0
Soelden	4.8	150	28,271	76	28	2707	162	11.5
SkiWelt Wilder Kaiser/Brixental	4.3	255	38,514	59	81	1492	139	12.7
Saalbach/Hinterglemm/Leogang	4.1	205	30,306	82	75	1769	137	9.3
Flachau/Wagrein/Alpendorf	4.1	194	25,308	72	91	1641	143	12.1
Panai/Hochwurzen/Hauser/ Kaibling/Reiteralm	3.7	130	22,629	73	94	1624	154	11.0
Kitzbuehel	3.6	158	33,128	55	46	1749	141	15.9
St. Anton/St. Christoph/Stuben	2.9	162	21,366	58	27	2206	157	14.2
Stubaier glacier	2.8	105	11,180	73	14	2812	242	12.0
Zillertalarena	2.8	129	22,162	65	39	1993	141	8.3
Mayrhofen/Hippach	2.6	161	26,314	74	63	2055	141	8.4
Silvretta Nova	2.6	124	15,727	59	52	1926	141	17.3
Hintertuxer glacier	2.5	110	11,972	65	09	2652	202	14.2
Lech/Zuers am Arlberg	2.4	150	15,418	63	27	2163	157	15.9
Hochzillertal/Hochfuegen/ Kaltenbach	2.4	145	17,198	77	84	2036	141	7.1
Serfaus/Fiss/Ladis	2.4	175	22,180	78	69	2222	141	6.8
Zauchensee/Flachauwinkl/Kleinarl	2.2	90	14,441	75	90	1812	130	12.1
Gastein Stubnerkogel-Schlossalm	2.0	90	16,394	54	37	1936	142	17.8
Kitzsteinhorn	2.0	42	14,229	73	14	2212	272	8.1
Nassfeld	1.8	101	15,407	79	100	1793	128	10.4
Obertauern	1.7	96	10,829	81	90	2045	157	8.3
Obergurgl/Hochgurgl	1.4	130	15,032	75	90	2657	165	11.2
Kaunertaler glacier	0.3	42	3903	38	16	2681	303	14.9
Moelltaler glacier	0.3	57	6094	66	65	2674	225	6.1

[a] Market share refers to the share of lift rides for the season 2001/2002.
[b] Lift capacity is total vertical lift capacity in persons per hour.
[c] Age is the average age of cable cars and chairlifts (excluding T-bar lifts) in years.

Table 3
Correlation matrix (*p*-values in parentheses)

	ln price of 1-day lift ticket (€)	ln price of 6-day ski pass (€)	ln total length of ski runs (km)	ln vertical transport metres persons per hour	Share of detachable chairlifts/ gondolas (%)	ln weighted. mean altitude of uphill lift stations (m)	ln ski season (days)	Slopes with artificial snow (%)
ln price of 1-day lift ticket (€)	1							
ln price of 6-day ski pass (€)	0.86 (0.00)	1						
ln total length of ski runs (km)	0.72 (0.00)	0.65 (0.00)	1					
ln vertical transport metres persons per hour	0.74 (0.00)	0.70 (0.00)	0.88 (0.00)	1				
Share of detachable chairlifts/ gondolas (%)	0.43 (0.00)	0.44 (0.00)	0.27 (0.01)	0.36 (0.00)	1			
ln weighted mean altitude of peak lift stations (m)	0.43 (0.00)	0.36 (0.00)	0.32 (0.00)	0.28 (0.01)	0.28 (0.01)	1		
ln length of ski season (days)	0.43 (0.00)	0.36 (0.00)	0.23 (0.03)	0.25 (0.02)	0.10 (0.38)	0.57 (0.00)	1	
Slopes with artificial snow (%)	−0.18 (0.11)	−0.02 (0.89)	−0.14 (0.17)	−0.03 (0.77)	0.04 (0.73)	−0.38 (0.00)	−0.37 (0.00)	1
ln age of transport facilities (years)	0.22 (0.05)	0.21 (0.06)	0.10 (0.38)	0.22 (0.05)	0.14 (0.21)	0.18 (0.11)	0.11 (0.31)	−0.12 (0.29)

Note: the number of observations is 84.

Table 4
Hedonic price model for the price of an adult lift ticket

	OLS		Robust regression	
	Coefficient	*t*-Value	Coefficient	*t*-Value
Dependent variable logarithm of the price of an adult a 1-day lift ticket in (€)				
ln total length of ski runs in km (ln KM)	0.034*	1.78	0.033*	1.61
ln vertical transport metres per hour (ln LC)	0.042**	2.48	0.046**	2.38
Share of high-speed chairlifts and gondolas (LCQUALITY)	0.120**	2.46	0.111***	2.76
ln average altitude of uphill stations (ln ALT)	0.020	0.36	0.036	0.74
ln number of operational days in the 2005–2006 season (ln DAYS)	0.137***	3.16	0.127**	2.50
Share of runs with snowmaking facilities (ln ARTSNOW)	−0.006	−0.23	−0.002	−0.06
Dummy variable Ski Arlberg	0.110***	7.16	0.107**	2.25
Constant	2.070***	7.09	1.965***	6.01
Wald-test: ln KM = ln LC = 0 (*p*-value)	0.00		0.00	
Wald-test: ln DAYS = ln ALT = 0 (*p*-value)	0.00		0.00	
Elasticity: share of high-speed chairlifts and gondolas (LCQUALITY)	0.071**		0.066***	
Adjusted R^2	0.67			
No. of observations	84		84	
Dependent variablelogarithm of the price of an adult a 6-day lift ticket in (€)				
ln length of ski runs in km (ln KM)	0.036	1.40	0.027	1.07
ln vertical transport metres per hour (ln LC)	0.024	1.02	0.033	1.34
Share of high-speed chairslifts/gondolas/funitels (LCQUALITY)	0.143**	2.35	0.199***	4.05
ln average altitude of uphill lift stations (ln ALT)	0.095	1.52	0.074	1.18
ln number of operational days in the 2005–2006 season (ln DAYS)	0.126*	1.91	0.152**	2.47
Share of runs with snowmaking facilities (ARTSNOW)	0.061*	1.95	0.069**	2.04
Dummy variable ski Arlberg	0.139***	7.06	0.148**	2.52
Dummy variable KI West ski pass	0.145***	5.10	0.147**	2.34
Dummy variable Zillertal Super ski pass	0.086***	3.55	0.079***	2.67
Dummy variable ski Amadé ski pass	0.027	0.89	0.022***	0.59
Constant	3.208***	8.39	3.161***	7.85
Wald-test ln KM = ln LC = 0 (*p*-value)	0.00		0.00	
Wald-test ln DAYS = ln ALT = 0 (*p*-value)	0.00		0.00	
Elasticity LCQUALITY	0.085**		0.119***	
Elasticity ARTSNOW	0.037*		0.042**	
Adjusted R^2	0.62			
No. of observations	84		84	

Note: *t*-Values are based on heteroscedasticity consistent standard errors. Significance at the 1%, 5% or 10% level is denoted by ***, ** and *, respectively. The dependent variable is the logarithm of adult 1-day lift ticket prices in peak season, adjusted for discounts on lift tickets with overnight stay at the ski resort.

6-day lift pass (lower panel), where the *t*-values are based on heteroskedastically consistent standard errors.[6] We also provide estimates of a robust regression technique, which is an iterative, weighted least-squares procedure that puts less weight on outliers (see column 2).

Overall, the fit of the OLS model is quite good, with an adjusted R^2 of 0.67 indicating that two-thirds of the variation in daily lift ticket prices across ski resorts can be explained by their difference in characteristics. The explanatory power of the hedonic price model is quite reasonable when compared to the results of other hedonic price models applied to the tourism industry based on cross-section data. For instance, using a hedonic model for hotel

[6] Since the standard errors may be dependent within clusters (associated ski areas), one can adjust for cluster dependency. However, unreported results indicate that the standard errors do not change much when this dependency is taken into account.

room prices, Monty & Skidmore, 2003 report an adjusted R^2 ranging between 0.60 and 0.72. Using characteristics and prices for 65 hotel rooms, Cox and Vieth (2003) report an adjusted R^2 of 0.71. Magnion, Durbarry, and Sinclair (2005) find an R^2 of 0.66 for package prices.

Recall that the derivative of the hedonic price equation with respect to each explanatory variable can be interpreted as the willingness to pay assuming the market is in equilibrium. Some variables are not included in the regression because they are not significantly related to lift ticket prices. These variables include the longest downhill valley run, year of the resort foundation, and average age of lift facilities. The total length of slopes in kilometres has a positive but statistically insignificant effect on the 1-day lift tickets. The individual insignificance of the length of trails possibly reflects the multicollinearity between the length of the trails and vertical lift capacity. Therefore, we also report the results of the Wald-test for the joint significance of both variables ($\ln KM = \ln LC = 0$), whose p-value of 0.00 indicates that vertical lift capacity and total length of slopes are highly significant. The magnitude of the impact of the total length of slopes is quite small. An increase of 50% in the total length of slopes (equal to increase of 33.7 km) leads to a 1.7% increase in lift ticket price (from €32.2 to €32.7). As expected, vertical lift capacity is positive and statistically significant with an elasticity of 0.042 based on the OLS estimates. This suggests that an increase in vertical lift capacity of 10% leads to an increase of 0.42% in lift ticket price. The share of high-speed chairlifts and modern cable cars in total lift capacity is positive and statistically significant at the 1% level. To provide an indication of the effect's magnitude, we calculate the elasticity of the price with respect to the share of fast lifts. The coefficient of 0.11 translates into an elasticity of 0.071 ($=0.59\times0.12$). Therefore, an increase in the share of high-speed lifts from 0.59 (based on sample means) to 0.69 would lead to a 1% increase in the lift ticket price. Both the logarithm of the average altitude of peak lift stations and the logarithm of the number of days of operation in the 2005–2006 season are significant at the 1% level when included separately.[7] When both variables are included in the regression, only the logarithm of the length of season remains statistically significant at the conventional significance levels. However, the Wald-test for the joint significance of both variables ($\ln DAYS = \ln ALT = 0$) rejects the hypothesis that both coefficients are zero. The multicollinearity is expected since the length of the ski season varies and depends on the altitude of the resort's peak lift stations. The coefficient of the share of ski runs with artificial snow is not significant. This is somewhat surprising: one would expect ski resorts that are characterised by good snow cover to be more attractive than others. However, there is a significant relationship between the price of a 6-day ski pass and the percentage of slopes covered by artificial snow (see Table 4 in the lower panel). Concerning the dummy variables indicating the availability of multi-area ski passes at a ski resort, we find that the Ski Arlberg dummy is highly significant; this shows that lift ticket prices are higher in two main sections of the ski resort (i.e. St. Anton and Lech/Zuers).

The parameter estimates of the hedonic price model, when taking the price of a 6-day ski pass as the dependent variable, are presented in the lower panel of Table 4. Again, the model fits the data quite well, with an adjusted R^2 of 0.62. The total length of the ski runs and the capacity of the mountain lift systems are both positive and jointly significant at the 1% level. Increasing the share of high-speed chairlifts, gondola lifts, and funitel systems, the average altitude of peak lift stations, and the duration of the ski season consistently increases the price of a 6-day ski pass. Concerning the magnitude of the implicit prices, we observe that the highest elasticities for a ski season length are approx. 0.126, while those for an average altitude of peak lift stations are approx. 0.095. Consumers are willing to pay only slightly more for increases in the total length of ski runs and total transport capacity with elasticities of 0.036 and 0.024, respectively. This means that skiers are expected to be willing to pay no more than €0.04 for a 1% increase in the total length of the slopes. Again, the share of high-speed chairlifts/gondolas is positive and highly significant with a coefficient of 0.14 and an elasticity of 0.085. The elasticity of the prices with respect to the share of slopes covered by artificial snow is somewhat lower at approx. 0.037. The results for the coefficients of the dummy variables measuring the interlinked ski resorts covered by the same lift pass show that the dummy variables for Ski Arlberg, KI West, and Ski Amadé are all positive and statistically significant. In contrast, the dummy variable for Zillertal is not significantly different from zero.[8]

4.2. Robustness checks

We provide several extensions of the basic hedonic price model. First, in order to allow for a non-linear relationship between the lift ticket prices and some of the explanatory variables, we use the piecewise spline technique. Second, we extend the hedonic price model by the inclusion of a measure of congestion. Third, we re-estimate the hedonic price model including the interaction terms of the explanatory variables. Table 5 shows the results of the linear spline analysis that allows for a more flexible functional form.

We use two different intervals for three right-hand variables (i.e. total length of slopes, transport capacity, and share of modern high-speed lifts). Our linear spline specification for the effect of the share of high-speed chairlifts and gondola lifts specifies one linear effect between 0 and 0.59 (labelled as [0; 0.59]), corresponding to an effect of the share of high-speed lifts less than 0.59, and another linear effect between 0.59 and 1. The coefficient of the share of modern chairlifts in the second interval is two times higher than in the first interval, indicating that the 1-day lift ticket prices are an increasing function of the share of high-speed lifts. However, the difference between these two coefficients is not significantly different from zero. This also holds for the two other variables. Not surprisingly, the estimated coefficients of the second interval that measure change in the slopes and change in the lift capacity indicate only small changes in the first interval.

Table 6 reports the results of the hedonic price model that is extended by a measure of congestion. The results show that the coefficient on lift capacity relative to the length of ski runs is significantly negative, whereas the coefficient on its square term is positive. This indicates a non-linear relationship between congestion and the price of a 6-day lift pass (see Graph 2). In particular, the elasticity of lift ticket prices with respect to the ratio of lift capacity to the length of ski runs is significantly negative for ski resorts characterised by a low lift capacity relative to the length of slopes. In contrast, a high ratio of lift capacity to the length of ski runs is associated with a positive impact on the prices of ski lift tickets. This is consistent with the results of Walsh et al. (1983), which say that the willingness to pay increases with shorter lift line waiting times.

A final robustness check concerns the possible interaction effects of the explanatory variables. For instance, it may be the case that the speed of lifts may be more valuable for customers

[7] Detailed estimation results are available upon request.

[8] Note that the effect on the price of the dummy variables is given as $((e\beta-1)\times100)$ (see Halvorsen and Palmquist, 1980).

Table 5
Results for hedonic price model estimated by spline function technique

	One-day lift ticket		Six-day lift pass	
	Coefficient	*t*	Coefficient	*t*
Spline function for the share of high speed lifts				
ln total length of ski runs in km (ln KM)	0.031	1.65	0.035	1.40
ln vertical transport metres per hour (ln LC)	0.046***	2.79	0.026	1.13
Share of high-speed lifts spline (ln LCSTRUC1 [0; 0.59])	0.067	0.87	0.117	1.08
Share of high-speed lifts spline (ln LCSTRUC2 [0.59; 1])	0.209*	1.98	0.189*	1.91
ln average altitude of uphill lift station	0.017	0.33	0.095	1.52
ln number of operational days in the 2005–2006 season	0.138***	3.33	0.126*	1.94
Share of runs with artificial snow	−0.007	−0.27	0.061*	1.94
Dummy variable Ski Arlberg	0.118***	6.73	0.144***	6.39
Dummy variable KI West ski pass			0.150***	4.78
Dummy variable ski Amadé ski pass			0.086***	3.52
Dummy variable Zillertal Super ski pass			0.029	0.90
Constant	2.079***	7.07	3.210***	8.32
Wald-test ln LCSTRUC1 = ln LCSTRUC2 (*p*-value)	0.68		0.37	
Spline function for length of ski runs				
ln total length of ski runs in km (ln km1 [0, 3.91])	0.033	1.52	0.041	1.28
ln total length of ski runs in km (ln km2 [3.91 5.54])	0.034	1.01	0.028	0.77
ln vertical transport metres per hour (ln LC)	0.042**	2.08	0.027	1.05
Share of high-speed chairlifts and gondolas (LCQUALITY)	0.120**	2.43	0.142*	2.33
ln average altitude of uphill lift station	0.020	0.35	0.094	1.46
ln number of operational days in the 2005–2006 season	0.137***	3.14	0.125*	1.89
Share of runs with artificial snow	−0.006	−0.23	0.062*	1.97
Dummy variable Ski Arlberg	0.110***	5.76	0.143***	6.60
Dummy variable KI West ski pass			0.149***	5.14
Dummy variable ski Amadé ski pass			0.087***	3.65
Dummy variable Zillertal Super ski pass			0.029	0.94
Constant	2.071***	6.85	3.188***	8.05
Wald-test ln km1 = ln km2 (*p*-value)	0.99		0.78	
Spline function for lift capacity				
ln total length of ski runs in km (ln KM)	0.033*	1.72	0.035	1.29
ln vertical transport metres per hour (ln LC1 [0, 8.73])	0.039	1.56	0.021	0.67
ln vertical transport metres per hour (ln LC2 [8.73 10.56])	0.045**	2.00	0.030	0.90
Share of high-speed chairlifts and gondolas (LCQUALITY)	0.120**	2.47	0.143**	2.37
ln average altitude of uphill lift station	0.022	0.38	0.098	1.46
ln number of operational days in the 2005–2006 season	0.135***	3.01	0.124*	1.82
Share of runs with artificial snow	−0.006	−0.24	0.060*	1.93
Dummy variable Ski Arlberg	0.109***	6.71	0.137***	6.60
Dummy variable KI West ski pass			0.141***	4.37
Dummy variable ski Amadé ski pass			0.084***	3.56
Dummy variable Zillertal Super ski pass			0.025	0.79
Constant	2.081	6.89	3.228***	8.13
Wald-test ln LC1 = ln LC2 (*p*-value)	0.86		0.83	

Note: significance at the 1%, 5% or 10% level is denoted by ***, ** and *, respectively. The number of observations is 84.

Table 6
OLS estimates of the hedonic price model augmented by congestion

	Coefficient	*t*-Value
ln vertical transport metres per hour (ln LC)	0.068***	5.29
Share of high-speed chairlifts and gondolas (LCQUALITY)	0.139**	2.41
ln average altitude of peak stations (ln ALT)	0.112*	1.75
ln number of operational days in the 2005–2006 season (ln DAYS)	0.109	1.62
Share of runs with snowmaking facilities (ln ARTSNOW)	0.066**	2.16
ln vertical transport metres per hour divided by length of ski runs (LC/km)	−0.743*	−1.80
ln (LC/km) squared	0.073*	1.72
Dummy variable ski Arlberg	0.143***	7.36
Dummy variable KI West ski pass	0.136**	5.08
Dummy variable ski Amadé ski pass	0.088***	3.57
Dummy variable Zillertal Super ski pass	0.029	0.92
Constant	4.798***	4.90
Adjusted R^2	0.63	
No. of observations	84	

Note: the dependent variable is the logarithm of the ticket price of a 6-day lift pass. Congestion is measured as the logarithm of ln vertical transport metres per hour divided by length of ski runs (LC/km) and its squared term.

visiting ski resorts with longer ski runs. Another example is that the snowmaking capacity is more valuable in low altitude resorts. In order to test these hypotheses, we re-estimate the hedonic price model augmented by the inclusion of one additional interaction term. Table 7 shows the change in adjusted R^2 when each of the possible interaction terms is included separately. The results indicate that adding interaction terms to allow for the heterogeneity of the effects does not improve the explanatory power of the hedonic price model in most of the cases. However, the multiplicative interaction term between the share of high-speed lifts and length of the runs leads to a slight improvement of the adjusted R^2. Table 8 shows the results of the hedonic price model extended by the interaction term between the share of high-speed lifts and the length of the runs. The coefficient of the interaction term is negative and significant, in turn indicating that the effect of high-speed lifts decreases with the length of the ski runs.

We also test the presence of spatial effects. Unreported results show that the spatially lagged dependent variable is positive but not significantly different from zero at the conventional levels, indicating the absence of neighbourhood effects. Furthermore, the LM test cannot reject the null hypothesis that the spatial autoregressive parameter *p* is significantly different from zero.

Table 7
Change in adjusted R^2 due to inclusion of interaction terms

	One-day lift ticket		Six-day lift pass	
	Adjusted R^2	Change in adjusted R^2	Adjusted R^2	Change in adjusted R^2
Basic specification	0.672		0.618	
Length of ski runs × lift capacity	0.670	−0.002	0.614	−0.003
Length of ski runs × share of high-speed lifts	**0.687**	0.017	**0.652**	0.038
Length of ski runs × altitude of uphill lift stations	0.668	−0.019	0.613	−0.039
Length of ski runs × number of days	0.677	0.009	0.614	0.001
Length of ski runs × share of ski runs with snowmaking	0.671	−0.006	0.620	0.005
Lift capacity × share of high-speed lifts	0.672	0.001	0.628	0.009
Lift capacity × altitude of uphill lift stations	0.670	−0.002	0.613	−0.015
Lift capacity × number of days	0.670	0.000	0.617	0.004
Lift capacity × share of ski runs with snowmaking	0.671	0.001	0.619	0.002
Share of high-speed lifts × altitude of uphill lift stations	0.678	0.006	0.630	0.011
Share of high-speed lifts × number of days	0.672	−0.006	0.618	−0.012
Share of high-speed lifts × share of ski runs with snowmaking	0.675	0.003	0.618	0.000
Altitude of uphill lift stations × number of days	0.673	−0.001	0.628	0.010
Altitude of uphill lift stations × share of ski runs with snowmaking	0.668	−0.005	0.616	−0.012
Number of days × share of ski runs with snowmaking	0.673	0.005	0.621	0.006

Table 8
Hedonic price model with multiplicative interaction between speed of lifts and length of ski runs

	One-day lift ticket		Six-day lift ticket	
	Coefficient	t-Value	Coefficient	t-Value
ln length of ski runs in km (ln KM)	0.096***	3.34	0.139***	3.60
ln vertical transport metres per hour (ln LC)	0.037**	2.15	0.017	0.74
Share of high-speed chair lifts/gondolas/funitels (LCQUALITY)	0.439***	3.38	0.673***	4.38
LCQUALITY × ln KM	−0.090**	−2.76	−0.150***	−3.90
ln average altitude of the peak lift station (ln ALT)	0.012	0.21	0.074	1.20
ln number of operational days in the 2005–2006 season (ln DAYS)	0.146***	3.35	0.144*	2.10
Share of runs with snowmaking facilities (ARTSNOW)	0.006	0.22	0.080**	2.68
Dummy variable ski Arlberg	0.110***	7.49	0.137***	7.25
Dummy variable KI West ski pass			0.125***	4.32
Dummy variable ski Amadé ski pass			0.078***	3.18
Dummy variable Zillertal Super ski pass			0.039	1.47
Constant	1.903***	6.72	2.971***	8.10
Wald-test: ln KM = ln LC = 0 (p-value)	0.00		0.00	
Wald-test ln DAYS = ln ALT = 0 (p-value)	0.00		0.00	
Elasticity LCQUALITY (25% percentile for ln km)	0.083**		0.104**	
Elasticity LCQUALITY (sample means)	0.051**		0.051**	
Elasticity LCQUALITY (75% percentile for ln km)	0.019**		0.002**	
Elasticity ARTSNOW	0.002**		0.046**	
Adjusted R^2	0.69		0.65	
No. of observations	84		84	

The tests for spatial effects were carried out for a range of spatial weight matrices based on a distance cut-off of 10, 15, and 20 km.

4.3. Benchmarking of ski resorts

One key parameter of interest is the predicted price level that serves as a measure of the ski resorts' quality. Table 9 presents the predicted price and the observed price of an adult 1-day lift ticket and the price of a 6-day ski pass (peak season) for the top 24 ski resorts based the robust regression method. The results for the 1-day lift ticket indicate that the highest-quality resort is St. Anton, followed by Lech/Zuers, and Ischgl. Soelden is ranked fourth. The predicted price can also be compared with the observed price to reveal the ski resorts that are, statistically speaking, significantly over- or underpriced. If the observed price is higher than the predicted price, skiers may overpay for lift tickets; if it is below the predicted price, the resort is a good value for the money.

The results indicate that Ischgl and SkiWelt offer the best deal for a 1-day lift ticket, with a difference of €3 between the observed and predicted price, whereas Soelden and Serfaus/Fiss/Ladis are over-priced by €2.5 and €3, respectively. For the two Arlberg ski resorts, the predicted price was very close to the actual average price. The predicted price of the 6-day ski pass indicates that SkiWelt (also with access to Kitzbuehel through Kitzbuehel Alpenpass) is the best ski resort in the country, followed by St. Anton and Lech/Zuers. Kitzbuehel (via the Kitzbuehler Alpenpass) comes in as the fourth best ski resort. Flachau/Wagrain/Alpendorf (#5), Planai/Hochwurzen/Hauser-Kaibling/Reiteralm (#6), Ischgl/Samnaun (#7), Zauchensee/Flachauwinkl/Kleinarl (#8), and Obergurgl/Hochgurgl (#9) are also in the top 10. The difference between the observed and predicted prices indicates that SkiWelt Wilder Kaiser-Brixental, Flachau/Wagrain/Alpendorf, Planai/Hochwurzen/Hauser-Kaibling/Reiteralm, Zauchensee/Flachauwinkl/Kleinarl, Hochzillertal/Hochfuegen/Kaltenbach, and Mayrhofen/Hippach are all characterised by a good price–quality relationship.

Table 9
Actual and predicted prices of ski lift tickets, 2005–2006

	Six-day lift pass				One-day lift ticket		
	Predicted, €	Rank	Actual, €		Predicted, €	Rank	Actual, €
SkiWelt Wilder Kaiser-Brixental (Kitzbueheler Alpen-Skipass)	193.0	1	190.0	St. Anton/St. Christoph/Stuben	39.7	1	39.5
St. Anton/St. Christoph/Stuben	189.5	2	189.0	Lech-Zuers am Arlberg	39.3	2	39.5
Lech-Zuers am Arlberg	188.5	3	189.0	Ischgl/Samnaun Silvretta Arena	38.0	3	35.0
Kitzbuehel (Kitzbueheler Alpen-Skipass)	187.0	4	190.0	Stubaier glacier	37.0	4	35.0
Flachau-Wagrain-Alpendorf	185.1	5	171.0	Soelden	37.0	5	39.5
Planai-Hochwurzen-Hauser-Kaibling-Reiteralm	184.1	6	171.0	Kitzsteinhorn	36.7	6	36.0
Ischgl/Samnaun Silvretta Arena	179.0	7	177.5	Saalbach Hinterglemm Leogang	36.5	7	36.0
Zauchensee-Flachauwinkl-Kleinarl	177.8	8	171.0	SkiWelt Wilder Kaiser-Brixental (Kitzbueheler Alpen-Skipass)	36.1	8	33.0
Obergurgl-Hochgurgl	176.7	9	190.0	Serfaus-Fiss-Ladis	36.0	9	39.0
Stubaier glacier	175.0	10	178.8	Hintertuxer glacier	35.9	10	35.0
Hochzillertal-Hochfuegen-Kaltenbach	174.8	11	168.0	Zillertal 3000	35.9	11	33.5
Zillertal 3000	174.4	12	168.0	Flachau-Wagrein-Alpendorf	35.8	12	35.0
Soelden	174.0	13	193.5	Obergurgl-Hochgurgl	35.7	13	38.0
Dorfgastein-Grossarl	173.5	14	171.0	Planai-Hochwurzen-Hauser-Kaibling-Reiteralm	35.6	14	36.0
Hintertuxer glacier	172.9	15	168.0	Kitzbuehel (Kitzbueheler Alpen-Skipass)	35.3	15	36.5
Serfaus-Fiss-Ladis	172.5	16	169.0	Hochzillertal-Hochfuegen-Kaltenbach	35.2	16	35.0
Saalbach Hinterglemm Leogang	172.0	17	173.0	Zillertalarena	35.0	17	34.0
Hochkoenig	170.5	18	171.0	Obertauern	34.7	18	34.0
Gastein Stubnerkogel-Schlossalm	170.4	19	171.0	Moelltaler glacier	34.6	19	35.0
Moelltaler glacier	169.9	20	169.0	Silvretta Nova	34.2	20	36.0
Obertauern	169.6	21	162.5	Nassfeld Hermagor-Kaernten	34.1	21	35.0
Kitzsteinhorn	168.8	22	172.0	Kaunertaler glacier	34.0	22	33.0
Zillertalarena	167.2	23	168.0	Zauchensee-Flachauwinkl-Kleinarl	33.9	23	35.0
Nassfeld Hermagor-Kaernten	165.6	24	169.0	Gastein Stubnerkogel-Schlossalm	33.7	24	36.0

Note: predicted prices are calculated based on the coefficients of the robust regression method in Table 4.

5. Summary and outlook

In the present paper, we apply the hedonic price model to estimate skiers' willingness to pay for various characteristics of ski resorts in Austria. The estimation results provide an indication of which characteristics Alpine skiers value and of how much more they are willing to pay for a lift ticket. Some of these factors (i.e. snowmaking capacity, lift capacity and quality of lift facilities, size of ski area, and the availability of multi ski area passes) are particularly important, because they can be controlled by the ski resort operators. The empirical analysis results based on 84 ski resorts for the season 2005/2006 indicate that the price dispersion among ski resorts can be mainly explained by their difference in lift capacity and speed of lift facilities, length of ski runs, and measures of snow conditions (i.e. altitude of uphill lift stations, duration of the resort's ski season, and percentage of slopes covered by snowmaking machines). Furthermore, ski resorts that are part of a greater ski network covered by the same lift pass can charge a significantly higher price. However, distance to population centres, average age of lift facilities, the length of the longest downhill run, and the foundation year of the resort all have no impact on lift ticket prices. Overall, the ski resort attributes account for between 61% and 68% of the variation in the price of 1-day lift tickets and 6-day ski passes. Note that the explanatory power of the model is quite good given the fact that there are many characteristics that are difficult to measure and are not accounted for. Examples of these intangibles are scenery, resort charm, and reputation.

However, the magnitude of the effect of the total length of ski runs and the corresponding aggregate lift capacity is quite small. Increasing the length of ski runs (in km) by 10% leads to an increase in the price of a 6-day ski pass by 0.36%. The corresponding figure for overall lift capacity is 0.24%. The quality of the lift facilities seems to be more important: A 10% increase in the share of high-speed lifts and cable cars leads to an increase in the price of lift tickets (i.e. 6-day ski pass) by 1.4%. Furthermore, the higher the mean altitude of a resort's uphill lift stations is, the more it will charge for lift tickets. Further, a 10% increase in the percentage of ski runs covered by snowmaking leads to an increase in the price of a 6-day lift ticket by 0.6%. To summarise, the willingness to pay for a small change in the quality characteristics is highest for ski resorts with modern high-speed lifts, good snow conditions, high slope height, a long season, and for those that are interlinked to other ski resorts covered by the same lift pass. The total length of ski runs and overall transport capacity is less important.

We also provide several extensions and robustness checks. In order to allow for a more flexible functional form, we also estimate a spline function. However, the log-linear functional form cannot be rejected. Furthermore, taking into account the possible interaction terms only marginally enhances the explanatory power of the hedonic price equation. Another aim of the present paper is to provide a ranking of ski resorts according to the observed quality of their characteristics using the predicted price of lift tickets as a measure of quality. The predicted ticket prices are obtained by using the standard hedonic price model, in which the lift ticket prices are regressed on the attributes of the ski resort. Our predicted prices for a 6-day ski pass indicate that SkiWelt (accessible via the Kitzbueheler Alpenpass) offers the best quality skiing in Austria, followed by St. Anton and Lech/Zuers. Kitzbuehel is ranked fourth. Ischgl/Samnaun, Obergurgl/Hochgurgl, and three of the larger ski Amadé resorts are also in the top 10. However, the crucial factor influencing the ranking of ski resorts is the treatment of the ski areas that are accessible via a multi-area ski pass. Not accounting for joint ski passes improves the ranking of ski resorts that are not part of a ski alliance. The predicted prices of a 1-day lift ticket indicate that St. Anton, Lech/Zuers, Ischgl/Samnaun, Stubaier glacier, and

Saalbach/Hinterglemm/Leogang are the best choice for a day of skiing in Austria. The predicted price can be compared with the observed price to reveal the ski resorts that are, statistically speaking, significantly over- or underpriced. We find that that Ischgl/Samnaun (only guest card holders) and SkiWelt offer the best deal for a 1-day lift ticket, with a difference of €3 between the observed and predicted price, whereas Soelden and Serfaus/Fiss/Ladis were slightly overpriced.

The present paper provides some new insights into the price–quality relationship of ski resorts. Several attributes are more important than others and may be useful for consumers (skiers), tour operators, tourism service providers, ski resort operators, and technical specialists. Investors in ski resorts and ski resort operators can use the findings of the hedonic price model in order to identify the facilities and services that the resort should offer to achieve higher prices. The results can be used to develop promotional and tourism marketing strategies. This is particularly important for ski resorts because of the high sunk costs involved. For instance, tourism marketing specialists should stress not only the quantity aspects of the resort (e.g. length of slopes and total lift capacity) but also the quality of the lift facilities (e.g. speed of lifts).

The application of hedonic price models to the prices of lift tickets seem to be promising, since the assumption of market clearance may be quite justifiable. The level of market concentration, as measured by the C4 ratio and the HHI indicates a substantial degree of competition among ski resorts. With regard to future research, two directions appear to be promising. First, research can be extended by applying a similar model to ski destinations in other countries. In particular, one can extend the analysis by including ski resorts in France, Switzerland, and Italy. Second, since between 30% and 40% of the variation of ticket prices are unexplained, it will be necessary to include additional variables into the hedonic price equation. For instance, expert ratings for resort charm and mountain scenery can be included in the hedonic price model. However, many characteristics of ski resorts are rather difficult to quantify.

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