Relating Competitive Pricing with Geographic Proximity for Hotel Room Offers

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ABSTRACT

This article examines the online pricing behavior of 3 to 5 star hotels in Germany in respect to local and supra-regional competition. By correlating over 3,000 online price observation series in relation to geographic proximity we examine the effect of increased market transparency due to online booking channels. We found a high correlation of pricing behavior within cities, also affecting wider regions and thereby showing strong market-wide price cohesion.

Key Words: competitive pricing, geographic proximity, hospitality, price correlations, online hotel room offers;

INTRODUCTION

With the hospitality industry advancing in e-commerce, i.e. share of online bookings, market transparency is reaching a level economists dreamed about for centuries. This opens up new opportunities for quantitative market research. In the course of these developments a research project (Walchhofer et. al. 2010) developed a framework for online market monitoring, applied in the field of tourism this project also created a reference data set of thousands of hotel room prices observed over several months on several online market places (booking channels).

The reference data set collected by the SEMAMO project amounts up to 5,000 hotel room offers over 90 days from 2010, whereof over 3,000 made it into analysis, based on data quality and density of observations. All offers under observation origin from German hotels and were collected from the six major booking channels for Europe. The set only holds hotel room offers for standard single and double rooms from 3 to 5 star hotels as they are considered to adapt prices more actively (Abrate et. al 2010) in regard to factors like demand and competition. Average estimated price change frequency lies about 7 days, which should be enough to show aspect of pricing behavior. Data shows only the supply side of markets, therefore no conclusions about the actual demand can be drawn.

This work investigates this data set for the aspect of competitive pricing in relation to geographic proximity. Main questions to be answered are (i) whether hotels are at all setting their prices according to competition? and (ii) is geographic proximity a significant factor when it comes to pricing according to other market players?

Besides economic rationale academic literature already indicates some use of competitive pricing as can be found in work of Koushik et.al (2012). This works explains how the InterContinental Hotel Group optimized their hotel room pricing by incorporating factors like occupancy, price elasticity and **competitive prices** gathered from the global hotel reservations system as well as online available sources. Since major hotel chains invest hundred millions of dollars in pricing systems there is a strong indication that also independent hotels take into account competition when setting their prices. Regarding the second research question, the work of Zhang et. al. (2011) provided proof for spatial auto-correlation for above 3 star hotels in the Bejing region while investigating hedonic price models. Therefore we are optimistic to proof our research questions to be true.

After the main concepts are defined in the Definitions section, we lay out the conducted analysis providing the core findings, which are summed up in a brief conclusion. In the end there is a small section for discussions before we list our references.

DEFINITIONS

Before starting with detailed analysis we define our main variables of interest, namely **competitive pricing** and **geographic proximity**. In tourism there are various definitions of the different pricing behaviors (Parsa, 2009). When talking about competitive pricing it regards to the behavior of setting the price according to competition in a sense that main price variations of the market are followed, mostly by keeping differences in

level to other competitors. This is similar to the definition of "point spread and price point" (Parsa, 2009), but without underlying the assumption of a default price point. Furthermore our definition should not be confused with "competition-based pricing" (Parsa, 2009), where the price is matched to that of the main competitors. After some consideration a simple pair-wise correlation of observed price series was chosen to measure the degree of competitive pricing, calculated after the method of Pearson also called "Pearon's r".

Competition exists on several levels. Especially in tourism there is competition between neighboring hotels, towns, destinations and even countries for different groups of customers. Due to the ease of information access competition in the hospitality industry got even more intense. So in general if the term competition is used in this article, it is not only restricted to micro rivalry of neighboring hotels.

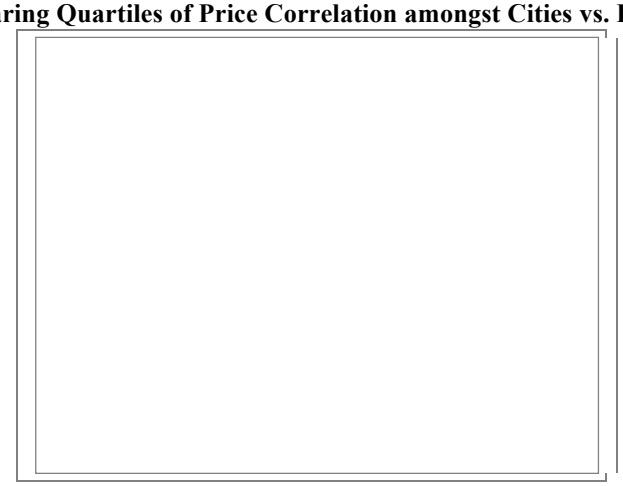
Geographic proximity is defined as the great circle distance of hotels measured in kilometers. To compute these distances we geo-coded (transformation in longitude and latitude locations) hotel addresses and computed distances by using the *rdist.earth* function of the R fields package (Furrer et. al 2010). The major advantage of this approach is that earth curvature is accounted for in the distance computation. Proximity is than of course the inverse of the computed distance.

ANALYSIS

To prepare our data for analysis we calculated the (cross) correlation and the great circle distance for every possible pair of observation series, amounting up to about 4.7 million pairs. Of course only one room per hotel was allowed for analysis in order to prevent bias for the geographic distance and pricing. Unfortunately our observations are not fully continuous, meaning we could not observe prices for all 90 days for every series. Mostly this results from a simple lack of availability of online prices (if a type of room of a certain hotel is not available via an online booking channel). Therefore our exploitable - in terms of a minimum number of entries - data base consists of over 4.5 million pairs.

In the attempt to answer the question whether hotels are adjusting their prices according to their competitors we compared correlations of prices amongst cities versus correlations of random room offers in our sample. Whereas correlation amongst cities shows how aware and reactive hotels are in their pricing behavior, correlating random price series serves two purposes. First it provides us with an independent comparison and secondly, and even more interesting, it indicates a degree of price coherence over the whole market. As can be seen in Fig. 1, there is a huge difference between the two groups.

Fig 1:
Comparing Quartiles of Price Correlation amongst Cities vs. Random



With an average inner city correlation of 0.68 and a median of 0.76 against the 0.19 of the random sample we can definitely see a competitive pricing behavior in the hospitality industry. These findings further imply that, next to facing similar demand, hotels must have sound knowledge of pricing strategies of their competitors or are very well informed about their actual prices, which seems more reasonable in the times online bookings holding an increasing share of over 60 %.

The more detailed distribution of the price correlations, depicted at left hand-side in Fig. 2, show the majority of correlations is on the right side, the density is even increasing with higher correlation. This pattern is

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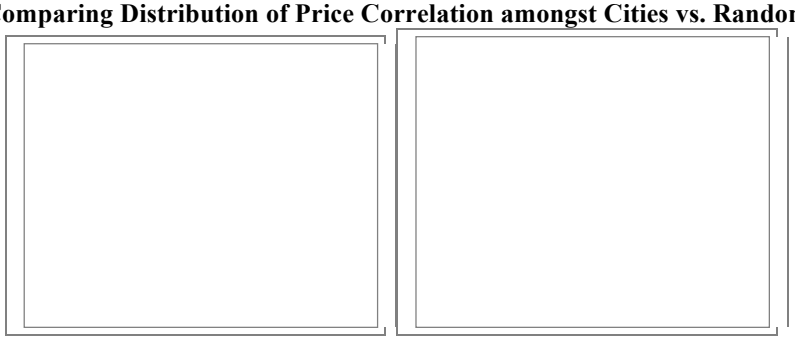
clearly backing up assumptions made above. The outstanding group for the highest correlation (0.95-1) could suggest several situations: (i) the existence of local rivals, monitoring their behavior with utmost intensity, hence facing same demand by sharing clientele (e.g., airport or inner-city hotels) or (ii) hotel chains having the same pricing strategy for various hotels situated in the same city.

The distribution of the random sample (see right hand side in Fig. 2) is also skewed to the right supporting the fact that competition in the hospitality industry is not a local phenomenon any more. Due to increasing market transparency customers often face the decision were to go at all, before they decide at which hotel to stay. Hence, destination management and positioning should also be important to local hoteliers. For sake of completeness, the small peak on the right of the random distribution could, similar to the inner city correlations, indicate a pricing behavior of country-wide operating hotel chains acting independent of micro markets. However, this assumption can statistically hardly be backed up with our data.

Fig 2:
Comparing Distribution of Price Correlation amongst Cities vs. Random



Challenging our second hypothesis, whether geographic proximity is a relevant factor for a competitive pricing behavior we conducted a simple regression analysis. First we classified the metric distance measure (originally in km) of the observational pairs into four separate groups with ordinal proximity: neighbors, city, region and distant hotels. The exact separation steps can be seen in Table 1 and are choosen according to the semantic of the group title.

Table 1:
Effects of Geographic Proximity on Pricing Behavior

Proximity Category (Grouping)	Est. Coefficient	t value	Pr(>|t|)
Intercept	0.1164	330.5	<2e-16 ***
Neighbors (< 5 km)	0.5767	483.3	<2e-16 ***
City (> 5 km < 15 km)	0.5126	449.9	<2e-16 ***
Region (> 15 km < 100 km)	0.2087	322.5	<2e-16 ***
Distant Hotels (> 100 km)	0.0600	141.0	<2e-16 ***
Regression Statistics:			
R^2	0.1086	Adjusted R^2	0.1086
Residual std. error	0.3527	Model p-value	< 2.2e-16

Table 1 clearly indicates a statistical significant effect of geographic proximity on competitive pricing behavior of hotels. With the coefficient of the intercept of about 0.12 reflecting the average random correlation seen in Fig. 1 for any price series correlated against each other. Furthermore we see that the mere fact of distance can have a huge impact on the pricing behavior. For the distance groups of “neighbors” and “city” we got an average coefficient of 0.57 and 0.51, respectively. On average these could mean that two hotels situated within a distance of 5 km show a price correlation of nearly 0.7 (intercept plus neighbors coefficient). Of course this effect in is not causal to its full extent, which is also indicated by the R^2 of about 11 %. Furthermore the proximity effect shows a clear drop-off in the other more distant groups.

Additional analysis of correlation of pricing behavior for different cities shows a very distinguished picture. As shown in Fig. 3 there are huge differences between cities behavioral similarities. Whereas even bigger cities like Köln, Nürnberg and Frankfurt show an impressively strong cohesion in pricing behavior, indicated by a high average correlation together with a low standard deviation, other cities like Bonn are

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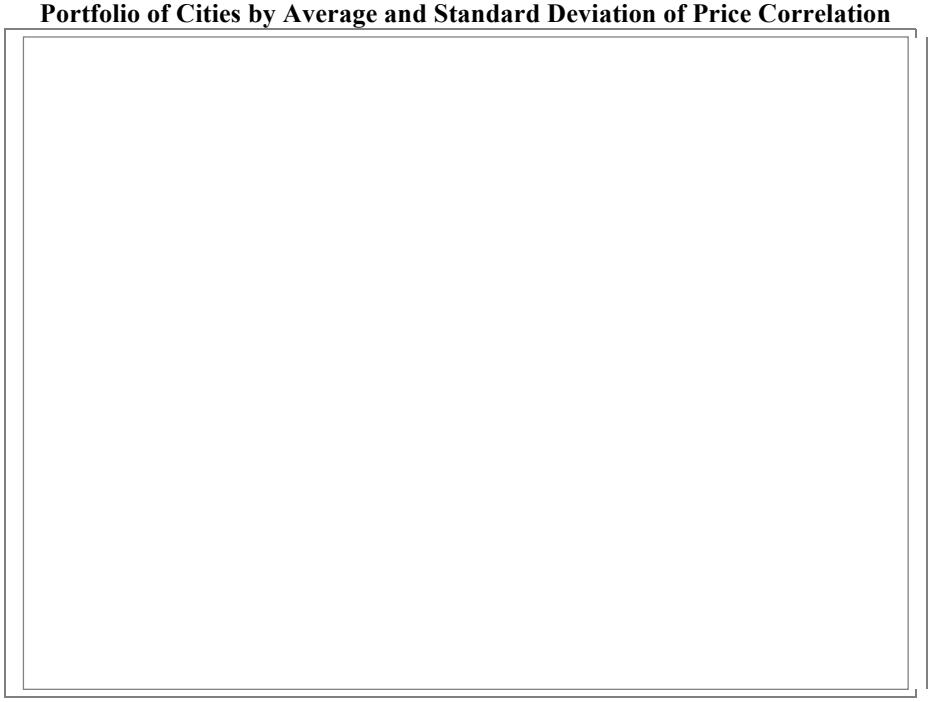
significantly nearer to the average random correlation of 0.19 in terms of price correlation. For the sake of readability only a small sample of the over 50 cities under investigation is shown in Fig. 3.

Fig3:
Portfolio of Cities by Average and Standard Deviation of Price Correlation



CONCLUSIONS

All in all the two basic questions this article addressed could be answered; hotels are setting their prices according to their competition and this competitive pricing is related to geographic proximity. We could show that pricing behavior of hotels situated in the same cities is extremely correlated, indicating a tight competition as well as sound knowledge of competition behavior. This knowledge may of course be enhanced by high market transparency due to the increasing market share of booking channels providing open access on the market information, especially price levels.

Furthermore we could show the behavior of competitive pricing not to be restricted to local geographic entities, but continuously affecting more distant supra-regional markets, though, decreasing with distance. The reason for this average cohesion in pricing behavior, indicated by the random sample shown in Fig. 1 and 2, may partly result from a "homogeneous" sample, in the sense that we only took observations from one country sharing the same macro economic conditions, demand base and other relevant industry factors like travel experience and reputation.

DISCUSSION

Although, we based our findings on independent and objective quantitative proof and logical arguments, the extents of real causal effects are hard to proof since the amplitude of additional effects is wide, especially if only the supply side of the market is considered. Therefore our findings may be limited, but nevertheless stating some basic relations at this development stage of the online hospitality industry.

In preparation of this article we also investigated the identification of market leaders and followers, which could be an interesting field when related to geographic proximity or supra-regional influence. Unfortunately, the density of data (i.e., daily observations) gave us a hard time denoting the precise lag to distinguish "leading" from "following", without going in circles.

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