AN ANALYSIS OF ONLINE PRICING BEHAVIOUR OF HOTELS IN HONG KONG

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A thesis submitted in partial fulfilment of the requirements for the degree of

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Certificate of Originality

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IBRAHIM MOHAMMED

Abstract

In the past three decades, the hotel industry has witnessed an explosive growth of Internet Distribution Channels (IDCs). These channels have created a vibrant online market for hotel rooms and contributed significantly to the growth of online pricing studies. So far, existing studies have examined rate disparity among different channels and offered suggestions about the channel(s) that offer lowest prices. Other studies have also investigated the dynamic pricing structure of hotels and determined the best possible time to book a hotel room in advance. Although research interest in online pricing of hotel rooms is continuing to grow, there has been a limited attempt to characterize online pricing behaviour in a systematic way using rigorous methodologies. Especially, studies to quantify the frequency of price change, direction of price change and magnitude or size of price change are still lacking. There are also no studies to identify the factors influencing these behavioural price patterns. Yet, knowledge of this kind can contribute to the strategic decision-making of customers and revenue managers.

Aiming to fill this void, this study sought to characterize online pricing behaviour of hotels in Hong Kong by examining: a) the frequency of price change; b) the pattern or direction of price change; and c) the magnitude of dynamic price dispersion within a booking window of seven days prior to check-in. The purpose was to identify market conditions, location characteristics and hotel attributes that can be used in conjunction with demand-based pricing policy to explain the possible heterogeneity in room pricing by different hotels. To address these goals, an extensive review of relevant literature was undertaken to develop an appropriate conceptual framework. The framework stipulates that pricing behaviour as described by

frequency of change, direction of price change and magnitude of dynamic dispersion is spatially-dependent and influenced by market characteristics and product attributes which are reflected in locational and hotel characteristics. This framework is underpinned by the spatial agglomeration theory and structure conduct performance (SCP) theory.

Appropriate to the data requirements of this study, comprehensive data were collected from different sources including an IDC (Kayak.com), Smith Travel Research (STR), the Hong Kong Tourism Board's (HKTB) publications, and Google map. The duration of the data collection was for a period of six consecutive months, spanning from May 2014 to October 2014, a period which covers both the peak and off peak seasons. Within this period, the target days for the data collection were all Tuesdays and Saturdays. These days were purposively chosen as the typical days representing weekday (business guests) and weekend (leisure customers) businesses respectively. In the end, a balanced panel data of 126 hotels involving 26 Saturdays and 26 Tuesdays were obtained for analysis. Given the different objectives of this study and the varying properties of the data, three econometric panel data models were used. The first set of panel data models were the Poisson and Negative Binomial count data models, which were used to analyse the factors influencing the frequency of varying hotel room rates. The second set of models were the Logit and Probit models, which were used to determine the factors that make a hotel more or less likely to increase or decrease its room rate. The last set of models were the spatial models (including Spatial Autoregressive, Spatial Error model and Spatial Durbin model), which were used to examine the interaction effects between the size of a hotel's room rate change and the effects from neighbouring hotels.

Primarily, the results of the analysis differed according to weekday and weekend. As such, the findings were presented along these lines to highlight the pricing behaviour of hotels towards leisure customers, who often stay on weekends, and business guests, who normally stay on weekdays. Based on the rankings of the hotels in terms of weekly average room rate, significant price mobility was found to be evident. That is, hotels moved up and down the cross sectional price distribution in a random fashion over time, suggesting that customers may not be able to learn from their past experience the hotels that offer the lowest or highest price. Examining the price mobility further, it was found that price fluctuations do not exhibit any consistent patterns either; room rates could go up, decline or remain unchanged. The noticeable difference however was that Saturday room rates were more likely to change frequently than those on Tuesdays. In terms of determinants, star rating, size and distance to the international airport were among the significant factors, besides demand, that influence the probability of a hotel increasing its room rate. In addition to these factors, seller density was also significant in influencing price fluctuations. Also, hotels in different administrative districts had different price fluctuations and tendencies to change price. Regarding the estimates from the spatial models, the results showed that the extent of dynamic price dispersion was positively related to market demand and the fluctuations in room rate of neighbouring hotels. Thus, hotels could be said to be practicing demand-based pricing and competitive pricing. Size of hotel, as in number of rooms, had a negative effect on the extent of dynamic price dispersion, an indication that because large-sized hotels have a lot of rooms to sell, their price variation was less substantial.

Considering the findings of this study, four significant contributions to knowledge and practice can be identified. As the foremost contribution, the study has offered a comprehensive framework that academics and industry practitioners can apply to understand the factors influencing online pricing behaviour. This framework has been tested with a large volume of frequently-changing real data. Second, the study has extended the application of SCP to the field of hospitality and augmented it with spatial agglomeration theory. That is, by spatially modelling the extent of variation in room rates within the context of SCP and finding evidence to support spatial dependence, the unique contribution to the hospitality literature is that because hotels services must be consumed at the location of production, the traditional measures of competition which are not spatially-defined may not be as important in understanding hotels' pricing behaviour as spatial competition which reflects Tobler's first law of geography (i.e. everything is related to everything else, but near things are more related than distant things).

Third, the findings have demonstrated the pricing behaviour of hotels in terms of frequency, direction and size as well as how these behaviours are related to market conditions, hotel characteristics and location attributes. In a sense, these findings can influence future hotel development as regards site selection. Last but not least, by providing empirical evidence to characterize online pricing behaviour, both hotel customers and managers can use this valuable information to enrich their knowledge and understanding of online pricing so that they can effectively make strategic decisions. In conclusion, much as this study has made some significant contributions to knowledge which can be used to improve RM practice, it has also revealed a number of viable opportunities for future research through its inherent delimitations

Keywords: dynamic pricing, price pattern, dispersion, spatial competition, Hong Kong

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CHAPTER 1: INTRODUCTION

1.0 Introduction

This chapter discusses pertinent issues and concepts that contextualize the study. The chapter commences with a statement of the purpose of the study, which is then followed by the background of the study. The background of the study focuses mainly on describing the evolution of Internet Distribution Channels (IDCs) (interchangeably referred to as online distribution channels) in the hotel industry. The rationale is to provide the motivation for the study and to explain how this platform has created an online market that is revolutionizing hotels' operations and for that matter online pricing of hotel rooms.

At this very onset, it is important to state that the term "behaviour" as used in conjunction with online pricing in this thesis does not directly refer to human actions or inactions as espoused in marketing or psychology literature. The term derives its meaning from the economics literature which simply refers to movements or changes and patterns in prices. In other words, online pricing behaviour, as used in this study, is defined as observable outcomes in price changes in the form of frequency of change, pattern (direction) of price change and magnitude (size) of price dispersion over a given period of time arising from the interplay of demand and supply which are nonetheless related to human actions and market conditions.

After the background of the study, the succeeding sections of the introduction are devoted to outlining the research problem and presenting the research gaps for investigation. The emerging research questions and corresponding research objectives are then presented together with the contributions of the study. In the final sections, the structure of the thesis is outlined and a summary of the major contents in each chapter is provided.

1.1 Purpose of the study

The growing importance and popularity of the Internet market in the hotel industry today have triggered widespread interests among hoteliers, customers and hospitality researchers to seek an understanding of room pricing behaviour on the Internet so that they can use the knowledge for strategic decision-making. As a result of these interests and the recognition that customers' familiarity with online pricing can promote the long-term viability of the Internet market, academic research on online pricing behaviour has been growing lately in the hospitality literature (Abrate, Fraquelli & Viglia, 2012; Alzua-Sorzabal, Gerrikagoitia & Torres-Manzanera, 2013; Balaguer & Pernías, 2013; Bitran & Caldentey, 2003).

Most of the extant studies have focused narrowly on examining online price data to describe price paths or the dynamics of room rates over time, without providing complete characterization of other aspects of online pricing behaviour, especially, the magnitude of dynamic price dispersion, the frequency of price changes and the patterns of price adjustment on the Internet; nor have they attempted to examine the factors influencing these pricing behaviours. Thus, the purpose of this study is to contribute to the emerging literature on online pricing behaviour by analysing the best available rates (BAR) of Hong Kong hotels on a price comparison website with the objective of identifying the factors that influence the frequency of price change (dynamic price adjustments), the direction of price change (price patterns) and the magnitude of dynamic price dispersion. The analysis focuses on the seven days prior to check-in, the period within which room rates are expected to change regularly.

Before proceeding to the background of the study, the meanings of best available rate, frequency of price change, patterns of price change and dynamic price dispersion as applied in this study are briefly explained as follows. Best available rate refers to the minimum rate offered to customers who do not qualify for special rates such as corporate rates, government rates and membership rates (Noone & Mattila, 2009). Frequency of price change is defined as the number of consecutive changes in the room rate within a defined booking period (Cecchetti, 1986; Powers & Powers, 2001). Price pattern refers to the overall direction of price change which can be positive (increase), negative (decrease) or zero (constant/unchanged) (Chen & Schwartz, 2008). Dynamic price dispersion is defined as the variations in the best available rate over a booking period of seven days relative to the average room rate (Mantin & Koo, 2009).

1.2 Background of the study

Over the past several decades, hotels' distribution channels have undergone some significant transformation and evolution (Buhalis & Law, 2008; Choi & Kimes, 2002; Green & Lomanno, 2012; O'Connor, 2008). Specifically, the traditional system of using brochures, guidebooks, travel agencies, tour operators, telephone, fax and call centres as the main distribution channels have expanded to include computerized systems such as the central reservation system, global distribution system, property management system and currently Internet-based systems, which involves hotels' own websites and third-party's such as Online Travel Agencies (OTAs: Buhalis & Law, 2008; Choi & Kimes, 2002; O'Connor, 2008).

Remarkably, the introduction of Internet-based systems of distribution is believed to have had the greatest impact on the distribution-channel landscape, thereby establishing itself as a viable and cost-effective system for marketing, selling and distribution of hotel products (O'Connor, 2008). Several studies conducted on Internet-based channels of distribution have indicated that a growing number of travellers are using the Internet to search and make lodging reservations due to its numerous benefits over the traditional system (Bai, Hu, Elsworth & Countryman, 2005; Chen & Schwartz, 2008; Jang, 2004).

Compared to the traditional system of distribution, the Internet-based systems offer customers the convenience to search, compare prices and make reservation on their own at a fraction of time and cost far lower than it takes on the traditional systems (Buhalis & Law, 2008). In addition to these benefits, online channels such as hotels' own website enable customers to obtain first-hand information about hotels' facilities without having to physically visit hotels' location or interact directly with hotels' staff or representatives (Connolly, Olsen & Moore, 1998). In terms of benefits to sellers, the Internet-based systems offer infinite capacity to host huge volume of information about hotel's products and services, provide constant access to a wider market area with practically no geographical boundaries, lower the marginal costs of selling and the menu cost of changing and updating information on room rates and inventory (Buhalis & Law, 2008; O'Connor, 2008).

In view of the numerous benefits of Internet-based systems of distribution, there has been a significant growth in online reservation of hotel rooms (Green & Lomanno, 2012; Noone & Mattila, 2009). In Noone and Mattila's (2009) study, the authors report that Internet-based reservations for major hotel brands and chains had increased from 27.1% in 2003 to 45.5% in 2007 with similar upward trend expected in the future. A direct consequence of this continuing growth of the online market is that it has considerably increased customers' exposure to hotels' revenue management practices at large and variable pricing in particular (Noone & Mattila, 2009; O'Connor, 2003). That is, due to the adoption of the internet-based systems of distribution, information on room rates that was previously not readily available to customers in the pre-Internet era is now completely transparent and accessible to customers at a click of a mouse. Taking advantage of the transparency in room rates, some customers, especially price-sensitive ones, are now in the habit of constantly searching on the Internet for best deals by engaging in price comparison, which is facilitated by meta-search engines such as Kayak.com (Zhang & Kallesen, 2007).

As customers get into the habit of comparing prices and continue to do so effortlessly with the support of price comparison websites, several hospitality scholars are of the belief that the Internet may have an influence on average room rates and the way hotel managers adjust prices over time or implement revenue management (Abrate, et al., 2012; Bitran & Caldentey, 2003; Christodoulidou, Brewer, Feinstein & Bai, 2013; Enz, 2003; Gazzoli, Kim & Palakurthi, 2008; Jayaraman & Baker, 2003; O'Connor, 2008). These scholars base their predictions on the economic arguments that because hotel operators also have access to price information on the Internet and are aware that customers engage in price comparison, they are bound to react to their competitors' prices on the Internet by adjusting their own rates appropriately.

Furthermore, Jayaraman and Baker (2003) argue that the Internet can enable the effective implementation of dynamic pricing due to the fact that it is relatively inexpensive to vary prices on the Internet than on the physical brick-and-mortar market. To shed more light on the influence of the Internet on pricing, the economics literature on the Internet market and online pricing is presented in the next section.

1.2.1 The Internet and online prices

Prior to the emergence of the Internet, academic researchers in Economics and Business had developed interest in studying the impact of information on prices (Marvel, 1976; Pratt, Wise & Zeckhauser, 1979; Stigler, 1961; Varian, 1980). Through these efforts, a specialized branch of economics known as information economics emerged in the 1960s. During the pre-Internet era, the predominant notion about the impact of information on prices was that, all other things being equal, an increase in the flow of information among market participants will promote competition and eventually lead to lowering of prices and elimination of price dispersion among sellers of an identical good or service (Lipczynski, Wilson & Goddard, 2009). With these notions in place, the impact of information on prices was said to be grounded in the neoclassical economic theory of market structures, which explains how price and output of an industry and firm are determined by using the assumption of profit maximization (Lipczynski et al., 2009). Going by the profit maximization assumption, the neoclassical theory of market structure posits that; in a market where information is readily available, the average price will be lowest and all sellers will charge a common price so that there will be no price dispersion (Chamberlin, 1933).

However, it was not until the 1960s when Stigler's (1961) article on *The Economics of Information* appeared in the *Journal of Political Economy* that researchers begun to formally test the impact of information on average price and price dispersion with actual data. Since then, academic interest in price dispersion has been soaring (see Baye, Morgan & Scholten, 2006 for a review of the numerous studies on price dispersion). Especially, the advent of the Internet and the subsequent emergence of online markets have enabled researchers to gain access to pricing data for identical goods and services sold on both the Internet market and the physical market for comparison (Brynjolfsson & Smith, 2000).

At the outset of the investigations on online pricing behaviour, some researchers (Bakos, 1997; Smith, 2002; Zettlemeyer, 2000) had opined that the Internet market has the ideal characteristics of a competitive market—frictionless, faster, cheaper and better—and for that matter should promote competition, lower average price and eliminate any price differences or price dispersion among sellers of identical goods or services. Corroborating this viewpoint, *The Economist* magazine in its November 20th (1999) edition, had stated that:

> *"The explosive growth of the internet promises a new age of perfectly competitive markets. With perfect information about prices and products at their fingertips, consumers can quickly and easily find best deals. In this brave new world, retailers' profit margins will be competed away, as they are all forced to price at cost" (p.112)*

However, for more than two decades that the Internet market has been in place, price dispersion studies in the market for durable goods have not gathered any conclusive evidence to confirm that the Internet indeed lowers average price and eliminates price dispersion. Rather, most of the studies have arrived at the conclusion that price dispersion is ubiquitous and persistent on Internet markets (Baye, et al., 2006; Baylis & Perloff, 2002; Brynjolfsson & Smith, 2000; Clemons, Hann & Hitt, 2002). Some studies have even suggested that price dispersion is higher on Internet markets than physical markets and therefore casting doubt on the ability of the Internet market to eliminate price dispersion (Brynjolfsson & Smith, 2000; Clemons et al., 20002). Indeed, anecdotal evidence suggested by some researchers indicates that the Internet may actually contribute to increasing search cost rather than lowering it. For example, Buhalis and Law (2008) suggest that in the presence of multiple sources of information on the Internet, search cost may increase because customers may have difficulty in making decisions quickly.

In the service industries, the growth of Internet-based distribution system among capacity-constrained firms such as airlines, hotels and car rentals has equally generated a great deal of research interest in online pricing behaviour. Particularly, the airline industry has produced a vast majority of these studies (Borenstein & Rose, 1994; Gaggero & Piga, 2011; Gerardi & Shapiro, 2009; Mantin & Koo, 2009; Obermeyer, Evangelinos and Püschel, 2013) for which Gerardi and Shapiro (2009) believe is as a result of the publicly available data in the airline industry. Generally, these studies have also confirmed the widespread existence of online price dispersion in the airline industry.

1.2.2 Online pricing behaviour in the hotel industry

From the studies that have been conducted on online pricing (Borenstein & Rose, 1994; Gaggero & Piga, 2011; Gerardi & Shapiro, 2009; Mantin & Koo, 2009; Obermeyer et al., 2013), there is no explicit definition of online pricing behaviour. However, it can be inferred from the studies of Brynjolfsson and Smith (2000) as well as Baylis and Perloff (2002) that online pricing behaviour is used to refer to observable differences and patterns in prices of identical goods that are measurable in terms of central tendencies and/or dispersions. Consistent with these scholars, this study uses the term "online pricing behaviour" to refer to quantifiable outcomes in the price setting of hotel rooms. More specifically it refers to the frequency of price change, direction or pattern of price change and magnitude of dynamic price dispersion.

As far as the existing literature in hospitality is concerned, limited attempts have been made to quantify these pricing behaviours. In a study conducted by Abrate et al. (2012), the authors provided evidence to indicate that dynamic price dispersion was substantial in European hotels' market but did not analyse the factors contributing to the magnitude of the dynamic price dispersion. The authors' concentration was on describing the dynamic pricing structure of hotels which they found to vary according to type of customer (weekday booking or weekend booking), star rating of hotels and number of hotels with available rooms in a city. Further, their findings revealed that, for a weekday booking, room rate declined as the check-in date approached while for a weekend, room rate tended to increase closer to the check-in date. In addition, the study also found that last-minute booking was characterized by higher price dispersion in higher-star category hotels than lower-star hotels and more pronounced for weekend bookings.

Empirical evidence regarding the frequency of price change on the Internet has only been provided in the markets for durable goods (Brynjolfsson & Smith, 2000) and the airline industry (Gillen & Mantin, 2009; Mantin & Gillen, 2011) but not in the hotel industry. In the light of the incomprehensive literature on online pricing behaviour in the hotel industry, this study focuses further attention on examining online pricing data to contribute to the emergent literature on online pricing behaviour of hotels.

1.3 Problem statement

For more than two decades, the hotel industry has been implementing dynamic pricing and revenue management systems with the primary objective of increasing revenue and maximizing profit (Hanks, Cross & Noland, 1992; Wirtz & Kimes, 2007).

Characteristically, revenue management systems allow hotels to implement variable pricing structure which discriminates among various customer groups for differential pricing and to vary room rates over time according to heterogeneity in customers, demand and supply situation, and competitive pressures in the market (Bitran & Caldentey, 2003; Gönsch, Klein, Neugebauer & Steinhardt, 2013; Shen & Shu, 2007).

Before the advent of the Internet as a distribution channel, existing channels of distributions were characterised by a high degree of information asymmetry due to the relatively high cost of searching for information on those channels. This situation resulted in limited hotel customers' awareness and familiarity with revenue management practices (Chen & Schwartz, 2006). However, with the introduction of Internet-based system of distribution, hotel customers have become increasingly exposed to dynamic pricing and revenue management practices, courtesy the innumerable websites that present room rates on the Internet (Noone & Mattila, 2009).

Subsequent to the transparency of room rates and customers' exposure to revenue management pricing, some hospitality researchers have underscored the importance of customers' familiarity and knowledge of pricing behaviour to the successful implementation of revenue management and long-term viability of the Internet market. For example, in Noone and Mattila's (2009) investigation of the effect of Internet price presentation strategies on customers' willingness to book a hotel room, they found that customers' familiarity with revenue management pricing practices improves customers' willingness to book online. Chen and Schwatz (2008) also demonstrated that patterns of room rates on the Internet affect consumers' intention to book. Previously, Rohlfs and Kimes (2007) as well as Wirtz and Kimes (2007) had also shown that customers' familiarity with revenue management practices moderates fairness perception of revenue management pricing. In another study by

Choi and Mattila (2006), the authors demonstrated that increasing the level of information to customers about hotels' variable pricing improves their fairness perceptions.

While consumer familiarity and knowledge of pricing behaviour have been documented to be important for the successful implementation of revenue management and promotion of long-term viability of the Internet market, there is surprisingly limited research on online pricing behaviour in the hotel industry as compared to the airline industry, where extensive research has been conducted (Borenstein & Rose, 1994; Gaggero & Piga, 2011; Gerardi & Shapiro, 2009; Mantin & Koo, 2009; Obermeyer et al., 2013).

The limited studies on online pricing behaviour in the hotel industry have focused narrowly on describing price paths or dynamic pricing structure without attempting to study other aspects of online price variations such as frequency of price change, pattern of price change and magnitude of dynamic price dispersion (Abrate et al. 2012; Alzua-Sorzabal et al., 2013; Balaguer & Pernías, 2013). Meanwhile, the equivalent studies in the airline industry have demonstrated the value of these studies in contributing to identify the sources of price advantage for strategic consumers' decision making. By analysing daily airline ticket prices, Mantin and Gillen (2011) found that fluctuations in the ticket prices contained some "hidden" information about future price drops which could provide useful information to guide the expectations of strategic consumers regarding future movement of prices.

Thus, for a subject of this importance, which has rather received limited attention in the hotel industry, it is appropriate to focus more attention on characterizing online pricing behaviour beyond the current discussion about dynamic pricing structure, which focuses mainly on describing price path to examining the factors that influence the different aspects of pricing behaviour. The present study contributes to this research agenda by addressing the following specific gaps.

First, it is widely acknowledged that the Internet enables hotel operators to frequently adjust room rates due to the implementation of revenue management software and the relatively low cost of changing prices on the Internet. However, to date, there is yet to be an empirical study in the hospitality literature that systematically investigates the frequency of price change over a given period of time and to examine the factors influencing the frequency of price adjustment. Second, the lack of studies that examine the predictors of price change limits the knowledge of strategic consumers and competitors who may wish to predict, at least, the direction of future changes in room rates based on observable characteristics of hotels and market structure.

Last but not least, empirical observation and literature on online pricing data suggests that room rates vary dynamically over booking histories due to the implementation of revenue management (Abrate et al., 2012; Bitran & Caldentey, 2003). However, little is known about the magnitude of dynamic price dispersion of different hotel segments. Moreover, there is the absence of empirical study to link the magnitude of dynamic price dispersion to location attributes of hotels and localized competition or market structure within which hotels operate. Especially, the effects of localized competition and spatial heterogeneities on dynamic price dispersion have not been investigated even though economic theory (i.e. the structure-conduct-performance theory) suggests there could be causal linkages. The closest study to this area in the hospitality literature is the one provided by Abrate et al. (2012), in which the authors link the structure of dynamic pricing (but not the magnitude of dynamic price dispersion) to the type of customer (weekday or weekend bookings), hotels' star rating and the number of hotels with available room during a booking period.

The lack of studies on these aspects of online pricing behaviour, altogether, compromises the depth of knowledge about online pricing behaviour and limits understanding as to the following questions:

1. How frequent do hotel room rates change and what factors influence the frequency of change?
2. What is the average direction of room rate change and what factors influence the patterns of change?
3. What is the average size of dynamic price dispersion and what factors influence the magnitude of the dynamic price dispersion?

1.4 Research objectives

In line with the stated research problem and the emergent research questions, the broad objective of this study is to analyse online price behaviour of hotels in Hong Kong to determine the frequency of price change, the patterns of change and the extent of dynamic price dispersion, and to identify the factors influencing these price-setting behaviours. Specifically, the study seeks to:

1. Measure the frequency of price change online and analyse the factors influencing it in the Hong Kong hotel market;

2. Determine the patterns of price change online and examine the influencing factors in Hong Kong hotel market; and

3. Quantify the size of dynamic price dispersion and identify the factors that determine its magnitude in Hong Kong hotel market.

To achieve the above objectives, a conceptual framework for this study is established on three major predictors: market structure characteristics; hotel characteristics and location attributes.

1.5 Context of the study

The focus of this study is on pricing behaviour of hotel rooms on the Internet, using Hong Kong hotel market as the study setting. Among other considerations, the Hong Kong hotel market is selected as a suitable setting for this study based on a number of reasons. Foremost among the reasons is that, a review of previous studies on online pricing behaviour points to Hong Kong hotel industry as an active and vibrant market, where numerous studies have already been conducted on its Internet market (see Law, Chan & Goh, 2007; Law & Wong, 2010; Tso & Law, 2005). By focusing further attention on this market, the findings of this study will complement those of early studies to offer more comprehensive knowledge of online pricing behaviour in this industry. This may then constitute a solid foundation for replication in other market settings.

Secondly, one of the goals of this study is to examine the influence of market structure, particularly spatial competition, on online pricing behaviour. From past empirical literature (Tsai & Gu, 2012), the Hong Kong hotel market presents itself as an ideal environment for analysing the influence of a competitive market structure on online pricing behaviour. Based on an analysis of the demand and supply situation in Hong Kong, Tsai and Gu (2012) concluded that the Hong Kong hotel industry was facing a serious problem of overcapacity, indicating that the market was very competitive. With this characteristic, it is anticipated that hoteliers in Hong Kong market practise competitive pricing and should therefore be more interested in understanding online pricing behaviour so that they can rely on Internet prices for their competitive pricing and strategic decisions.

Thirdly, unlike many other hotel markets, the Hong Kong hotel market provides a pillar support to a thriving and burgeoning tourism industry which attracts travellers from all over the world. According to official statistics from the Hong Kong Tourism Board, more than 53% of hotel occupancy in Hong Kong comes from tourists or pleasure travellers (Hong Kong Tourism Board, 2011). Since the study seeks to analyse online pricing behaviour, it is believed that its findings will benefit a great pool of tourists who depend on the Internet to search and make lodging reservations.

Lastly, the Hong Kong hotel market consists of leading hotel brands and chains, as well as independent world-class hotels which are using the Internet platform to market, distribute and sell rooms. Therefore, given the industry's good mix of all hotels, the findings of this study may be indicative of the general industry practices in other markets since the international chains often have similar revenue management practices around the world. In the ensuing paragraphs, a brief introduction of the Hong Kong hotel market is presented to highlight the market's performance and characteristics.

According to official statistics available from Hong Kong Tourism Board (HKTB), the government institution responsible for hotels in Hong Kong, the hotel industry has experienced tremendous growth over the years. From 95 hotels in 1990 supplying 36,749 rooms, the size of the industry has more than doubled to 225 hotels in 2013 with a total room supply of 70,017 (HKTB, 2013; 1990). Out of the 225 hotels, 34 hotels are classified as high tariff A hotels, which is the upper end of the market, 83 hotels fall in the category of High tariff B hotels, and another 88 are classified as medium tariff hotels, which constitutes the lower end of the market. The remaining 20 hotels are unclassified. The HKTB classifies hotels into high tariff A, high tariff B and medium tariff on the basis of an aggregated weighted score of hotel's achievement in room rates, staff to room ratio, location, facilities and business mix of hotels (HKTB, 2011).

In terms of market performance, the average market occupancy rate for a recent past five years (2009-2013) for all categories of hotels, stood at 86.4%, with an average daily room rate (ADR) of HK$ 1,274 (approximately US$165.60 using a conversion rate of HK$1=US$0.13) as at 2013. Table 1.1 provides further detailed statistics on the industry performance of all hotels responding to the annual surveys of HKTB for the various years.

Table 1. 1: Summary of industry performance statistics from 2009 to 2013

Indicator	2009	2010	2011	2012	2013
Number of hotels	167	175	190	211	225
Total number of rooms for all hotels	59,627	60,428	62,830	67,394	70,017
Number of rooms available for sale per day	45,199	48,228	51,517	38,658	40,139
Number of rooms occupied per day	35,244	41,778	46,019	34,719	35,579
Hotel occupancy (%)	78	87	89	89	89
Average number of guests per rooms	1.60	1.60	1.66	1.25	1.26
Average daily room rate (HK$)	960	1,118	1,356	1,489	1,447
Average rate per guests night (HK$)	605	709	1,003	1,302	1,137
Revenues per guests night (HK$)	1,004	1,178	1,552	1,935	1,736
Total revenue (HK$MN)	19,656	26,960	34,990	38,144	40,814
Total expenses (HK$MN)	14,347	17,615	20,454	22,836	24,065
Income (loss) before taxes (HK$MN)	5,309	9,345	14,536	15,308	16,749
As % of total revenue	27.0	34.70	41.5	40.1	41.0
Per available room (HK$)	117,455	193,771	282,165	283,113	284,895

Source: compiled by author from various issues of Hong Kong Hotel Industry Review reports (2009-2013). Note: All amounts are presented in Hong Kong dollars and, for approximation, HK$1=US$0.13.

On the global front, the Hong Kong hotel industry is one of the leading markets in the world and amongst the top in Asia Pacific. Out of the numerous hotel markets around the globe, the Hong Kong market was ranked 4th and 20th respectively in occupancy and RevPAR in the world, based on Smith Travel Research data (Delloite, 2009).

1.6 Significance of the study

In the light of the pertinent research gaps that have been identified for investigation, the significance of this study are evident in the academic and practical contributions that the findings make to fill these gaps and advance the dearth of literature on online pricing behaviour in the field of hospitality. Basically, the online pricing behaviour literature is still emerging in hospitality literature and has not yet enjoyed the same richness as its counterpart, the airline industry (Borenstein & Rose, 1994; Gaggero & Piga, 2011; Gerardi & Shapiro, 2009; Mantin & Koo, 2009; Obermeyer et al., 2013). Thus, the analyses in this study make germane contributions both to academia and practice.

1.6.1 Academic contributions

As far as existing studies in hospitality literature are concerned, this study is the first attempt to broaden the literature on online pricing behaviour to three critically important aspects—frequency of price change, patterns of price change and magnitude of dynamic price dispersion—and to adapt the structure conduct performance theory to analyse the factors that influence such behaviours. Thus, the major academic contributions of this study are outlined as follows:

First, the study offers a framework for studying online pricing behaviour regarding frequency of price change, pattern of price change and magnitude of dynamic price dispersion based on the structure conduct performance theory, adapted to suit the hotel industry and hospitality literature. Specifically, the structure-conduct nexus of the SCP theory is adopted as a baseline theory and augmented with hotel and location characteristics to determine their influences on online pricing behaviour. In other words, the proposed framework suggests that in addition to market structure variables, which may influence hotels' conduct regarding pricing behaviour, the characteristics of hotels as well as the attributes of the location within which they operate may have a role to play considering the fact that hotel rooms must be consumed at the location where they are produced.

This framework goes to complement the several studies that have found location and hotel-related attributes to be important determinants of room rates in the hospitality literature (Abrate, Capriello & Fraquelli, 2011; Bull, 1994; Chen & Rothschild, 2010; Hung, Shang & Wang, 2010; Israeli, 2002; Lee & Jang, 2011; Monty & Skidmore, 2003; Schamel, 2012). Second, the study contributes empirical literature to the emerging area of online pricing studies in hospitality to enrich our understanding of the pricing behaviour of hotel rooms on the Internet. More importantly, the empirical analysis has served as a validation of the proposed conceptual framework for studying online pricing behaviour in the future.

1.6.2 Practical contributions

Given the growing interest among hoteliers and hotel customers to gain an understanding of the behaviour of room rates on the Internet, the findings of this study go a long way to contribute to this end. By providing empirical evidence to explain online pricing behaviour, both customers and hotel practitioners should have a better understanding of online pricing behaviour in general that can become the basis for their strategic decisions. Specifically, the findings contribute to knowledge in the following ways.

To suppliers of hotel rooms and managers, the findings make the following three specific contributions. First, the findings highlight the extent of dynamic price dispersions in the hotel industry and relate the dispersion to hotel and location characteristics so that practitioners may have a better understanding of how hotels in different segments, for example, vary their prices dynamically and the frequency at which they undertake such price variations. In a sense, this knowledge can help hotel practitioners to identify factors within their control that influence price dispersion. Stated differently, by analysing the factors which contribute to price dispersion, hotel practitioners might become aware of the sources of price variation that can give them advantage over their competitors.

Second, the findings bring to light the impact of spatial heterogeneities on pricing behaviour so that hotel managers may learn how the presence of neighbouring hotels affect the frequency of price adjustment, the pattern of price adjustment and the magnitude of dynamic price dispersion, based on the specific location of their hotels. With this knowledge, hotel practitioners should be in a position to anticipate and deal with the effects of local competition. Finally, with regard to the influence of seller density, the findings could be interpreted as giving an indication of the likely effects of new entrants into the Hong Kong hotel market on online pricing behaviour of existing hotels. This is especially relevant for the Hong Kong hotel market because as per the available data from the HKTB, there are an estimated number of 58 hotels, with total room supply of 7,831, that are expected to enter the industry by the end of 2015 (HKTB, 2013).

Similar to industry practitioners, hotel customers can benefit from the findings of this study in the following two specific ways. First, the findings provide empirical evidence on dynamic pricing structure that may enable prospective customers to determine the best time to make an advance booking online. By examining the patterns in the dynamic pricing structure, it should be possible to determine when prices are generally declining or increasing so that strategic customers can use this information to guide their timing of booking a hotel room. Second, the findings also provide empirical evidence on the factors influencing online price fluctuations so that for customers who wish to predict future changes in prices, they may know the predictors. As indicated by Mantin and Koo (2011), the close examination of the pricing data has revealed some "hidden information" on how hotels in different segments and locations vary their prices.

1.7 Definitions of key concepts

It is valuable to define and explain the meanings of the key concepts driving this research. These concepts are set out in Table 1.2.

|Table 1. 2: Definitions of key concepts

Key Concepts	Definitions/Explanations	References
Revenue management	The application of information systems and pricing strategies to allocate the right capacity to the right customer at the right price at the right time	Kimes and Wirtz (2003)
Best available rate (BAR)	The best non-qualified room rate available on a given day. That is, the rate quoted to customer if he or she does not qualify for a special rate.	Noone and Mattila (2009)
Dynamic pricing	The planned action of a seller to change posted prices at arbitrary times within the selling horizon (that is, "dynamically") in order to respond to changes in demand or competition-related conditions with the goal of maximizing total profit	Gönsch et al., (2013)
Online pricing behaviour	Frequency of price change, patterns of price change and dynamic dispersion on an Internet Distribution Channel	Brynjolfsson and Smith (2000); Baylis and Perloff (2002)

Frequency of price change	The number of consecutive changes in the room rate	Cecchetti (1986); Powers and Powers (2001)
Price patterns	the overall direction of price change which can be positive (increase), negative (decrease) or zero (constant/unchanged)	Chen and Schwartz (2008)
Dynamic price dispersion	The variations in the best available rate over a booking period of seven days relative to the average room rate	Mantin and Koo (2009)

1.8 Organisation of the thesis

This thesis is organised into five chapters, namely; introduction, literature review, methodology, findings and discussion, and conclusion. Chapter 1 has introduced the study by presenting the background information leading to the study. This is followed by a presentation of the problem statement which highlights the research gaps identified for this study. The purpose and objectives, as well as the significance of the study have also been presented. Chapter 2 provides a comprehensive review of the literature which covers both the theoretical and empirical studies. The theoretical literature is further divided into sections covering, the different types of market structures, structure conduct performance theory and the relevant theories on price dispersion. The conceptual framework, developed from the problem statement, theory and past research is also presented in this chapter together with the hypothesized relationships and justifications.

Chapter 3 examines the methodological issues relating to the study and a discussion of the appropriateness of the methodology adopted for this study. The chapter further describes the research design, model specification and characteristics, data collection, and, finally, the estimation techniques and statistical package used. Chapter 4 presents and discusses the findings. The conclusions and suggestions for future research are presented in the final chapter.

1.9 Summary of the chapter

This chapter has provided detailed information to constitute an introduction to this thesis. In a systematic manner, the chapter began with the purpose of the study which stated *inter alia* that; it aims to analyse online pricing behaviour of hotels in Hong Kong with the objective of identifying factors that influence the frequency of price change, the pattern of price change and the magnitude of dynamic price dispersion. This was followed by a provision of the background information that inspired this study. Essentially, the content of the background information covered the evolution of hotels' distribution channels to the present-day Internet-enabled channels, which have contributed significantly to making room rates become transparent online.

After the background information, the research problem was clearly stated. Following the statement of the research problem, the research questions and objectives were succinctly outlined together with a presentation on the study context. The next section provided the significance of the study which was divided into academic contributions and practical importance to industry practitioners and hotel customers. In the last but one section, definitions of key concepts driving the research were provided. Lastly, the organisation of the entire report was outlined to provide a roadmap that guides readers' anticipations. The next chapter presents the extensive literature review conducted on online pricing behaviour and the related literature.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presents a critical review of the relevant literature on online pricing behaviour and provides the conceptual framework for this study. The presentation of the literature review covers both the theoretical literature and empirical studies. Under the theoretical literature, a generic review of room pricing and hotel revenue management is first presented to provide a background that leads on to a better understanding of online pricing behaviour. This is then followed by an in-depth examination of pricing behaviour theories regarding price dispersion, frequency of price change and pattern of price adjustment, highlighting the possible factors that could influence these pricing behaviours.

Afterwards, the critical review of empirical studies on online pricing behaviour follows. In this part of the review, hotel industry-specific studies are the main focus; but a reasonable amount of attention is also devoted to reviewing studies from the airline industry considering the fact that it shares many similar characteristics and practices with the hotel industry, especially, in terms of pricing and revenue management. The conjunctive review of empirical studies from both industries amply demonstrates the lack of richness in online pricing behaviour studies in the hotel industry relative to the airlines, and therefore contributes to further highlight the research gaps identified for this study.

In the final section, the theoretical literature is combined with the empirical evidences from prior studies to develop a suitable conceptual framework that best addresses the research problem and fills the research gaps and objectives. Lastly, a summary of the various theories and empirical studies are provided to conclude the chapter.

2.1 A brief overview of the study context

As previously stated in Section 1.1 of the preceding chapter, this study sought to investigate online pricing behaviour of hotels in Hong Kong with the main objective of analysing the factors that influence three aspects of online pricing behaviour—frequency of price change, pattern of price change and magnitude of dynamic price dispersion —using daily data from different demand seasons. To achieve this purpose and objective, the study adapts a widely accepted theoretical model from the field of Industrial Organisation (IO) economics known as the Structure Conduct Performance (SCP) theory as the fundamental framework and augments it with the relevant literature from hotel studies. Basically, the SCP theory stipulates that the conduct (behaviour) and performance of firms in any given market are related to the structure of the market in which the firms operate. Stated differently, the SCP suggests a causal relationship from the structure of a market to the conduct of firms in that market and to performance of the firms and vice versa.

By adopting the SCP as an underlying framework of this study, online pricing behaviour of hotels is considered to be a form of hotels' conduct which should be related to the market structure within which hotels operate. Hence, in this context, a substantial part of the literature review centres on defining and describing the market structure of the hotel industry so as to identify the essential elements or characteristics of the market that could be influencing online pricing behaviour. In addition, the study draws from the pricing literature in the hotel industry to assert that certain characteristics of hotels and location attributes are inseparable parts of hotels' products and are therefore capable of influencing pricing behaviour as well.

With this brief overview, the subsequent sections of the literature review now commences with a discussion on room pricing in the hotel industry and proceeds to examine the application of revenue management in the hotel industry as it relates to dynamic pricing.

2.2 Room pricing in the hotel industry

In the day-to-day operations of hotels, room pricing is one of the important decisions hotel operators have to make on a regular basis (Steed & Gu, 2005). In a year, a typical hotel may have to determine rates for at least 365 times and where a hotel has multiple room types and different customer segments; the potential number of rates could even be more (Cross, Higbie & Cross, 2009). The importance of room pricing in hotel business has been emphasized in the literature and can be explained in terms of its role in achieving the operational and financial goals of a hotel.

From an operational viewpoint, pricing can be used as a tool for inventory management to encourage or discourage demand in the short run (Bitran & Caldentey, 2003; Choi & Kimes, 2002). In terms of financial goals, pricing has a direct impact on yield or revenue (Kimes, 1989; Raya, 2011) and therefore implementing the right pricing policies becomes a means to increasing revenue (Cross et al., 2009). Conversely, for a wrong pricing decision (either over pricing or under-pricing), a hotel may suffer dire consequences both in the short term and long term. In the short term, under-pricing, for example, can lead to significant loss in gross operating profit while in the long term; over pricing can result in loss of customers, low occupancies and ultimately low profits or loses (Steed & Gu, 2005).

In making pricing decisions, hotel operators are usually concerned with how to determine the right price(s) at the right time and how to adjust the optimal prices over time to achieve the desired goals of the hotels (Kimes, 2002; 1989; Orkin, 1988). These concerns, to an extent, are addressed by the price theory in economics which recommends that pricing decisions should be based on the principles of demand and supply and the associated concept of price elasticity of demand. Applying the principles of demand and supply to room pricing, hotel operators are expected to adjust room rates upward when demand for hotel room is high relative to supply and adjust them downward when demand is low relative to supply. Equivalently, the principle of price elasticity of demand dictates that, hotels should charge a higher price to customers with lower price elasticity of demand (i.e. price-insensitive customers) and a lower price to customers with high price elasticity of demand (i.e. price-sensitive customers).

In practice, however, hotels' pricing decisions do not always follow these economic principles. Cross et al. (2009) explain that practitioners do not normally follow these principles because it is challenging to predict demand and measure price elasticity of demand accurately at every point in time. In addition to these challenges, there are several factors, other than price elasticity of demand that hotel operators need to take into account when making pricing decisions which are no less challenging to measure or predict accurately. These factors — including the marginal cost of selling an additional room, the extent of competition in the market, the relative price and quality of service offered by other hotels, the length of stay in a hotel and the value attached to building relationship between the vendor and the customers — have generated a stream of pricing strategies for the hotel industry (Collins & Parsa, 2006; Steed & Gu, 2005).

In a survey of existing pricing strategies in the hotel industry, Steed and Gu (2005) classify the principal ones into four categories, namely, cost-based pricing, market-based pricing, a combination of cost- and market-based, and best-practice pricing. Similar to Steed and Gu (2005), Collins and Parsa (2006) also indicate that the most common pricing practices in the hotel industry are cost-based, consumer-driven and competition-driven pricing. Collins and Parsa (2006) explain that: cost-based pricing is an approach to pricing in which hotel products are priced to yield an equitable profit above their cost of production; consumer-driven pricing is a market approach to pricing in which prices are determined by the amount that customers are willing to pay for the product and finally competition-driven pricing determines price that will ensure that a targeted market-share can be attained by a firm.

While the various pricing strategies have been touted as rational approaches, none of them has emerged to be universally applicable. Each strategy has its own merits and demerits (see Collins & Parsa, 2006; Steed & Gu, 2005 for a discussion on the advantages and disadvantages of the various pricing strategies). In view of the lack of a universally-applicable pricing strategy, hotel operators continue to depend on their good judgements as much as they depend on simple mathematical calculations and complex revenue management algorithms for effective pricing. Thus, it is no surprise that hotel operators are increasingly becoming interested in online pricing behaviour of their competitors so that they can be guided by the fundamental underpinnings to make good judgements about their own pricing decisions.

2.3 Application of revenue management pricing in the hotel industry

Revenue management, previously known as yield management (Cross, 1997), has become an inextricable part of the discussion on room pricing (Jaucey, Mitchel & Slamet, 1995). Originally, yield management started in the airline industry in the early 1970s as an operations management function, focusing mainly on capacity management and overbooking, with little discussion on pricing (Bitran & Mondschein, 1997; Feng & Gallego, 2000; 1995; Gallego & van Ryzin, 1997; 1994). Pioneering works on modern-day revenue management can be traced back to Littlewood (1972), who presented a seminal work on yield management in which he described a basic model to explain booking limits and inventory control system. This model was later advanced by Belobaba in 1987.

Since then, there have been several publications about yield management describing the theory and practice of it, especially after the initial success story of the American Airlines' (AA) experience with yield management (see McGill & van Ryzin, 1999 for an early review of revenue management research in the airline industry and other transporation sectors). As the success story of the AA's yield management practices continued to be trumpeted, the development and application of yield management were extended to other capacity-constrained service industries such as hotels (Chen & Freimer, 2004; Kimes, 2004; 1989), car rental businesses (Anderson & Blair, 2004; Geraghty & Johnson, 1997) and restaurants (Kimes, 2005; 1999), causing a redefinition of the concept of yield to revenue per available inventory (Hayes & Miller, 2011). In a comprehensive review conducted by Chiang, Chen and Xu (2007), the researchers identified additional sectors or industries where revenue management was applicable.

According to Hansen and Eringa (1998), the hotel industry was the first to adopt revenue management after the airline industry, and this occurred in the 1980s, when the industry was facing numerous problems such as excess capacity, competition, liquidity constraints and recession. The hotel industry has continued to implement revenue management to date. Providing reasons for the continuing adoption and implementation of revenue management, Cleophas, Yeoman, McMahon-Beattie and Veral (2011) suggest that the evolution of superior management science models, technological development and the acceptance of revenue management in enhancing the bottom line have a role to play. Previously, Cross (1997) had also attributed the growth in revenue management adoption to the remarkable gains from yield management that were widely reported in the literature.

As an early adapter of yield management, the hotel industry has documented its own definitions of yield management. These definitions aptly emphasize the point that the basic objective of yield management in the hotel industry is to maximize revenue or yield. Few examples of these definitions are cited here to illustrate this point and to delineate the critical elements of revenue management in the hotel industry. Beginning with the definition by Kimes (1989), yield management is "the process of allocating the right type of capacity to the right kind of customers at the right price so as to maximize revenue or yield" (p.15). Evaluating Kimes' (1989) definition, it can be noted that the use of "capacity" makes the definition applicable to the hotel industry as much as it is applicable to any other industry where the inventory is relatively fixed.

By contrast, Donaghy, McMahon and McDowell (1995) provided an industry-specific definition of yield management, where it is viewed as "a revenue maximization technique which aims to increase net yield through the predicted allocation of available bedroom capacity to pre-determined market segments at optimum price" (p.140). Similarly, Jaucey et al. (1995) offered a definition of hotel yield management as "an integrated, continuous and systematic approach to maximizing room revenue through the manipulation of room rates in response to forecasted patterns of demand" (p.25).

Based on the few definitions presented above, it can be emphasized that revenue management in the hotel industry revolves around two major management decisions: inventory management (which involves, overbooking, inventory and duration controls) and pricing (which is the aspect of revenue management that this study is concerned with). In revenue management pricing, the fundamental principle is that different customers have different willingness to pay different prices for the same product. Therefore, by effectively differentiating among the various customer groups, discriminatory or differential pricing should yield more revenue than uniform pricing across-board (Cross et al., 2009; Kimes, 1989; Lieberman, 2011; 2003). Applying this principle, revenue management pricing will require that, for the same inventory, customers who are less price-sensitive are charged higher than those who are more price-sensitive (Lieberman, 2011; 2003). Conversely, it also means that, for the same inventory, price-sensitive customers should pay lower rate compared to price-insensitive customers.

In sum, revenue management pricing can be said to be the source of the plurality of variable pricing schemes in the hotel industry, including dynamic pricing which has attracted a lot of attention amongst academics and industry practitioners, especially after the creation of the online market. Jayaraman and Baker (2003) discuss how the Internet enables the implementation of dynamic pricing while Bitran and Caldentey (2003) provide an overview of the growing literature on dynamic pricing policies and their connection to revenue management.

2.4 Dynamic pricing

As part of the strategies to increase revenue from room sales, hotels are in the habit of applying dynamic pricing policy (Abrate et al., 2012; Sahay, 2007) which can be defined as "the planned action of a seller to change his posted prices at arbitrary times within the selling horizon (that is, "dynamically") in order to respond to changes in demand or competition-related conditions with the goal of maximizing total profit (Gönsch, et al., 2013, p.507). In the past, the absence of accurate information, high transaction cost of changing prices and the huge investment in the necessary software and hardware required to implement revenue management had limited the application of dynamic pricing (Elmaghraby & Kesiknocak, 2003). However, the situation is different today; almost every hotel now applies dynamic pricing.

In the application of dynamic pricing, hotels base their pricing policy on the same principle of revenue management idea that hotel customers consist of heterogeneous groups (e.g. high valuation customers and low valuation customers) who make reservations at different times and are willing to pay different prices for identical rooms. With this idea, dynamic pricing is applied to determine an optimal pricing structure that varies over the selling period so that the best combination of high-valuation and low-valuations can be captured to balance demand with supply and maximize the expected room revenue (Bitran & Mondschein, 1994; Gallego & van Ryzin, 1994).

As hotels and other travel-related industries continue to implement dynamic pricing, the theoretical literature on optimal dynamic pricing has been growing (Bitran & Mondschein, 1997; Feng & Gallego, 2000; 1995; Gale & Holmes, 1993; Gallego & van Ryzin, 1994). Most of these theories suggest that under different assumptions of market structures, the optimal dynamic pricing structure may depend on customers' arrivals, room availability, option value of unsold stocks and customers' ability to act strategically (Sweeting, 2012). For example, Gallego and van Ryzin (1994) proved that under the assumptions of monopolistic competition and a Poisson process of customer arrival, the optimal dynamic pricing structure becomes a function of room stock and the length of time horizon.

Badinelli (2000) also discussed a model of optimal dynamic policy in which the optimal policy depends on the time remaining until the booking date, the number of vacancies and whether booking is done by revealing willingness to pay ("revealed price") or concealing it ("hidden price"). In another theory, Su (2007) suggested that the optimal dynamic pricing structure depends on consumers' valuation for the product and degree of patience (waiting costs). In his analysis, Su (2007) demonstrated that when low-valuation customers are sufficiently patient to wait for last-minute sales while high-valuation customers are sufficiently impatient to buy early at higher prices, then the optimal pricing structure should be declining as the booking date approaches. But, when high-valuation customers are more patient to wait than low-valuation customers, then prices should dynamically increase to discourage inefficient waiting and capture the consumer surplus from high-valuation customers who will miss the initial low prices.

In spite of the abundant theoretical literature on dynamic pricing, empirical analysis of dynamic pricing structure in the hotel industry is rare. In an analysis of the dynamic pricing structure of hotels in eight European cities, Abrate et al. (2012) concluded that there was no uniform pricing structure across hotels in the various cities. In some cities, prices declined as the booking date approached while in others higher prices were observed closer to the booking date. Further, their findings suggested that the structure of dynamic pricing was related to factors such as type of customer (weekday or weekend booking), star rating of hotels and the number of suppliers showing availability of rooms.

In the airline industry however, a relatively higher number of studies on dynamic pricing have been conducted. Piga and Bachis (2007) found that, consistent with the theoretical prediction of Gale and Holmes (1993), the dynamic pricing structure of British low-cost carriers followed the advance discount model, where prices are higher closer to the booking date. Similarly, Lott and Roberts (1991) justified the last-minute higher prices in the airline industry with the argument that those prices included the opportunity cost from the airlines' risk of flying empty seats. Other studies have also shown that airlines' dynamic pricing structure is U-shaped (Alderighi & Piga, 2010; Piga & Bachis, 2007) and J-curved (Gaggero & Piga, 2010); a relationship the authors describe as a reflection of the profile of online bookers, where early-bookers and middle-bookers are usually leisure travellers with high demand elasticity and late-bookers are mostly business travellers with low elasticity of demand.

2.5 Characteristics of the hotel industry and the adoption of dynamic pricing

In principle, every industry or business has the potential to apply dynamic pricing. However, the existence of certain characteristics or features in some industries promotes the successful and effective application of dynamic pricing policies. In the hotel industry, for example, these characteristics have been identified to include the following: relatively fixed capacity; perishable inventory; unstable or fluctuating demand; high fixed cost and low variable cost; advance saleable products; segmentable market demand and predictable demand (Cleophas et al., 2011; Cross, 1997; Kimes & Chase, 1998). These characteristics are briefly explained below to show how they enable the implementation of dynamic pricing.

2.5.1 Relatively fixed capacity

In the hotel context, capacity refers to the maximum physical and non-physical units of inventory that a hotel can realistically sell within a given period of time (Cleophas et al., 2011). In terms of physical capacity, the number of rooms or number of beds is typically the unit of measurement while time slot (say night stays) is the unit of measurement of non-physical capacity (Badinelli, 2000). For a hotel, once construction is completed, the physical capacity, in a technical sense, becomes relatively fixed, at least in the short term and can only be expanded in the long term. But even where hotel operators wish to increase the capacity of a an already operational hotel, the relatively high cost of adding an incremental unit of capacity and the length of time it may require to do so can act as constraints to increasing the capacity. With relatively fixed capacity, hotels are unable to adjust the number of rooms easily to accommodate temporary increases or decreases in demand and therefore apply dynamic pricing as one of the inventory management techniques to derive the maximum expected revenue from their fixed-capacity rooms.

2.5.2 Perishable inventory

Like many other relatively-fixed-capacity service industries (e.g. airline, car rental and restaurants), the hotel industry sells a perishable inventory. As an industry which depends largely on room sales for revenue, the hotel industry’s inventory does not only refer to the physical facilities or rooms, but also the time slot allocated to the use of the facilities (Cleophas et al., 2011). Thus, for any time slot that a room remains unsold, the implicit revenue from that room cannot be saved; it is automatically lost because that same time slot can never be salvaged and resold at a different time. In other words, the perishability of room inventory naturally occurs with the passage of the time. In view of this, hotel managers always strive to maximize room revenue by minimizing unsold rooms and they are able to do this by sometimes resorting to dynamic pricing practice such as last-minute discounting (Schwartz, 2000; Hanks et al., 1992).

2.5.3 Cost structure

Generally, hotel business involves substantial fixed capital investment (Donaghy et al., 1995; Reich, 1993). At the same time, the variable cost of running a hotel and the marginal cost of selling rooms are fairly low compared to the high fixed cost and marginal production costs (O'Connor & Murphy, 2008). Given the high-fixed cost but low-variable cost structure, hotels adopt pricing strategies that generate enough revenues to cover at least all the variable cost and probably part of the fixed costs (Hanks et al., 1992). In tune with this principle, the policy of dynamic pricing allows hotels to lower price during off-peak season, when marginal production cost may be relatively lower and raise them during peak seasons, when the marginal production cost is relatively higher (Edgar, 2000).

2.5.4 Unstable or fluctuating demand

For its role in determining price, demand is one of the important variables that hoteliers are constantly aspiring to have a handle on. However, there are extremely large numbers of factors, including time, which renders demand in the hotel industry unstable (Gallego & van Ryzin, 1994; Kimes, 1989). In general, demand for hotel rooms may vary by time of the week, by day of the month and by season of the year (Kimes, 1989). Typically, demand is low on weekdays (Sunday to Thursdays) and high on weekends (Fridays and Saturdays). With the unstable nature of demand in the hotel industry, the application of dynamic pricing becomes a tool for shifting or re-allocating demand in between times since pricing can be used to influence consumers' time of consumption (Choi, 2011; Choi & Kimes, 2002).

2.5.5 Advance saleable product

More often than not, the decision to buy a hotel product occurs ahead of the actual date of consumption. For group sales the decision to buy hotel product can even be made a year from the check-in date (Kimes, 1989). In view of this, it is a common practice for hotels to open rooms for sale in advance of their actual date of consumption so that customers who make up their minds early to buy hotel products can be captured (Alzua-Sorzabal et al., 2013). By embarking on advance sale of hotel products, hoteliers need to implement optimal dynamic pricing policy that will capture an adequate number of low valuation customers who typically make an early decision to buy hotel products without turning away high valuation customers who are bound to make a last-minute purchase decision (Su, 2007).

2.5.6 Segmentable market demand

As stated previously, the market for hotel product consists of heterogeneous buyers who are willing to pay different prices for the same product and are largely identifiable or segmentable by certain characteristics or factors (Yelkur & DaCosta, 2001). Weatherford and Bodily (1992, p.832) observe that "the common mechanism used to segment customers in yield-management situations is the time of purchase; that is, the less price sensitive customers generally wait until the last minute to make reservations." Besides the time of purchase, other characteristics or mechanisms for segmenting hotel customers include type of guests (business or leisure; frequent, regular or first-timer; free individual traveller or group), day of booking (weekday or weekend), length of stay (short-stay or long-stay) and socio-economic demographics (occupation, club membership, age, place of residence) (Ladany, 1996; Yelkur & DaCosta, 2001). Due to hoteliers' ability to segment customers based on the time they make reservations, dynamic pricing is practised in the hotel industry.

2.5.7 Predictable demand

In general, demand for hotel rooms comes from different customers who make reservations through different channels. There are those who make reservation through the hotel's direct channels such as calling the hotel and using the hotels' websites. But, there are others who also make hotel reservations through the hotel's indirect channels such as online travel agencies and tour operators. With an appropriate information system in place, demand from these multiple sources can be predicted and used to determine an optimal dynamic pricing policy.

2.6 Online pricing behaviour: frequency, pattern and magnitude

Prior to the emergence of the Internet market, which is believed to have contributed to the growth of online pricing behaviour studies (Baye et al., 2006), academic interest in pricing behaviour in general had been developed among economics and business researchers (Pratt et al., 1979; Salop & Stiglitz, 1982; 1977; Shilony, 1977; Sobel, 1984; Stigler, 1961; Stokey, 1981; 1979; Varian, 1980). As early as 1883, Bertrand (as cited in Davis, 2005) provided a model of pricing behaviour to illustrate how strategic interaction and competition between two sellers (in a duopoly market) of an identical good can drive their prices down to a competitive low level and cause the sellers to charge the same price. Later on, Hotelling (1929) and Chamberlin (1933) offered complementary models that support Bertrand's prediction.

Over the last two to three decades, studies on online pricing behaviour have been growing in three main directions. First, there are studies that have sought to determine whether the Internet contributes to lower prices or not by comparing the average prices of identical goods sold on both the brick-and-mortar market with average prices of the same goods on the Internet. Second, there are also studies that have sought to examine if the Internet market, which is conceived to be frictionless, contributes to eliminating any price dispersion among sellers of an identical goods (Baye, Gatti, Kattunman & Morgan 2005; Baylis & Perloff, 2002; Brynjolfsson & Smith, 2000; Clemons et al., 2002). Lastly, there are studies that have also sought to determine whether the relatively low cost of changing price on the Internet has facilitated frequent price changes or not (Baylis & Perloff, 2002; Gillen & Mantin, 2009; Jayaraman & Baker, 2003; Mantin & Gillen, 2011).

With the explosive growth of Internet-based channels of distribution in the hotel industry, customers and hoteliers have become interested in online pricing behaviour for two reasons. First, the Internet has made prices transparent and almost costless for customers and sellers to collect and process information in real time. For example, through a price comparison websites, customers can compare room rates across different hotels, different channels and at different times just by the click of a mouse. Second, the Internet-based distribution system has enabled the implementation of dynamic pricing (Baylis & Perloff, 2002; Jayaraman & Baker, 2003), which has led to the general mentality that last-minute deal can be found on the Internet (Chen & Schwartz, 2008).

Notwithstanding the growing interest in online pricing behaviour among hoteliers and customers, there is yet to be a comprehensive study that characterizes online pricing behaviour in the hotel industry. In an effort to fill this gap, this study derives from the past studies of Baylis and Perloff (2002) and Brynjolfsson and Smith (2000) to define online pricing behaviour as involving dynamic price dispersion, frequency of price change and pattern of price change. The next section (section 2.6.1) of the literature review is devoted to explaining the meanings of these three aspects of online pricing behaviour as used in this study.

2.6.1 Definitions: dynamic price dispersion, frequency, and pattern

Dispersion in the literal sense refers to the spread of some values around a central point. In economics literature, price dispersion is defined as a measure of the variation or differences in prices of an identical product or service (Lipczynski, et al., 2009). From this definition, it implies that, for price dispersion to occur, there must be more than one seller whose products are identical or similar and whose prices differ. Quite frequently, price dispersion is confused with a closely-related term known as price discrimination, which refers to the practice of a single seller who sells the same product at different prices. But the distinction between price dispersion and price discrimination is important to be maintained because Borestein and Rose (1994) have argued that discriminatory pricing is one of the causes of price dispersion.

In the hotel-industry literature, price dispersion connotes the same meaning as in the economics literature except that in addition to price dispersion that occurs across different sellers/channels, there is also price dispersion with regards to the same seller's price due to the fact that hotels apply dynamic pricing policy (Demirciftci, Cobanoglu, Beldona & Cummings, 2010; Pan, Ratchford & Shankar, 2004; 2002).

The difference between the two forms of price dispersions in the hotel industry are commonly delineated by referring to dispersion in prices of the same hotel within a single channel as dynamic or inter-temporal price dispersion because this may occur over a booking period due to the implementation of dynamic pricing policy. On the other hand, price dispersion that occurs across different channels is commonly referred to as rate disparity.

As one of the key aspects of online pricing behaviour to be examined in this study, dynamic price dispersion is defined as the variations in the best available rate over a booking period of seven days relative to the average room rate (Mantin & Koo, 2009). The other aspects of online pricing behaviour to be examined are frequency of price change and pattern of price change. Frequency of price change is defined as the number of consecutive changes in the room rate (Cecchetti, 1986; Powers & Powers, 2001). Price pattern refers to the overall direction of price change, which can be positive (increase), negative (decrease) or zero (constant/unchanged) (Chen & Schwartz, 2008).

2.6.2 Measurements: dynamic price dispersion, frequency and pattern

The literature on pricing behaviour is rich with statistics that can be used to measure price dispersion, frequency of price change and pattern of price change. Most of the indices for measuring price dispersion originate from the economics literature on income inequality measurements and have enjoined wider acceptability. Table 2.1 provides a comprehensive list of the various indices for measuring the different aspects of pricing behaviour together with brief descriptions and references that have applied them in empirical studies.

Table 2. 1: Measures of price dispersion

Pricing behaviour	Measurements	Brief description	References
Dynamic Price dispersion	Range	Difference between the largest and smallest price. This measure is scale sensitive.	Brynjolfsson and Smith (2000); Clay, Krishnan,Wolff and Fernandes (2002)
	Trimmed range	Difference between the second largest and second smallest prices. To control for possible outliers	Brynjolfsson and Smith (2000)
	Price index	Ratio of highest price to the lowest price	Pratt et al. (1979); Schwieterman, (1985)
	Price gap	Difference between the two lowest prices	Baye, Morgan and Scholten (2004)
	Variance	The average variability around central measure (mean). The measure is scale sensitive	Dahlby and West, (1986); Pratt et al. (1979)
	Standard deviation	The square root of the variance. This measure is also scale sensitive	Dahlby and West, (1986); Pratt et al. (1979)
	Interquartile ratio	Describes dispersion in one quartile relative to another quartile	Gerardi and Shapiro, (2009); Lach (2002)
	Coefficient of variation	The ratio of the standard deviation to the mean	Alderighi (2010); Escobari and Gan (2007); Giaume and Guillou (2004); Sorenson (2000)
	Gini coefficient	It is a measure of inequality in prices over the entire prices	Alderighi (2010); Borenstein and Rose (1994); Gerardi and Shapiro, (2009); Obermeyer et al. (2013)

	Atkinson index	A measure of inequality that can be set to emphasize a certain portion of the distribution	Hayes and Ross (1998); Obermeyer et al. (2013)
	Entropy index	A measure of inequality that is sensitive to price variation in the lower end	Hayes and Ross (1998)
	Power divergence statistic (PDS)	A measure of goodness-of-fit which compares observed frequencies with expected frequency	Mantin and Koo (2009); Read and Cressie (1988)
	Directed divergence statistic (DVS)	A goodness-of-fit measure which compares divergence across different distributions	Alam, Ross and Sickles (2001)
Frequency of price change	Count of price change	The number of times room rates change within a booking period	Cecchetti (1986); Powers and Powers (2001)
Price pattern	Aggregate change	The overall direction of room rate change	Chen and Schwartz (2008)

Given the variety of indices that measure price dispersion, a logical question to ask is: which of these statistics is the best measure of price dispersion? There is no straightforward answer to this question. Each of the indices has its strengths and weaknesses and may be used to capture different aspects of the price distribution. For example, while the Gini coefficient is known to attach more weight to the middle portion of the price distribution, the entropy index is sensitive to price variations at the lower ends of the distribution and the Atkinson index allows researchers to choose which part of the distribution they want to emphasize (see Alam et al., 2001; Hayes & Ross, 1998 for further discussion on the strength and weaknesses of various indices). Due to the difference in the indices, it is not uncommon for empirical studies to adopt more than one index to ensure that the findings are robust and reliable (Borenstein & Rose, 1994; Hayes & Ross, 1998; Obermeyer et al., 2013). It is also important to add that due to the differences in the properties of some of the indices, the choice of an index may impose some restrictions on the kind of statistical analysis to be done and the interpretation of the results.

2.7 Theories of price dispersion

There are several well-known theories on price dispersion that seek to explain why price variation may exist and persist for homogeneous goods and services (Brynjolfsson & Smith, 2000; McMillan & Morgan, 1988; Shilony, 1977; Sutton, 1980). Baylis and Perloff (2002) categorize these theories into four. The first is Brynjolfsson and Smith’s (2000) theory, which argues that price dispersion is an outcome of the random noise in an immature market, where the dispersion persists in so long as the market remains immature.

The second group refers to the theories that attribute price dispersion to the strategic behaviour of firms, regarding the implementation of randomized mixed pricing strategies to prevent customers from identifying seller(s) who offer the lowest price. Examples of these theories include Varian (1980) and Shilony (1977). The third group refers to theories that consider price dispersion to be due to product heterogeneity that creates or builds customer loyalty (McMillan & Morgan, 1988; Sutton, 1980). The final category refers to theories that explain price dispersion as an outcome of price discrimination (Salop & Stiglitz, 1982; 1977; Sobel, 1984; Stokey, 1981; 1979).

In another study, Baye et al. (2006) provide an extensive review of the theories of price dispersion but adopts a slightly different classification scheme which makes it easy to rationalize price dispersion in both the online and offline market contexts. Per their classification, price dispersion theories are grouped under search-theoretic models or information clearinghouse models. Both categories of price dispersion theories are widely accepted, but their underlying assumptions sometimes diverge, making them suitable to different markets at varying degrees. The subsequent sections review price dispersion theories based on Baye et al. (2006) schema to highlight which set of models are more relevant to online price dispersion.

2.7.1 Search-theoretic models

Baye et al. (2006) identify numerous theories of price dispersion under the category of search-theoretic models. Representative examples include Benabou and Gertner (1993), Braverman (1980), Burdett and Judd (1983), Carlson and McAfee (1983), Dana (1994), Daughety (1992), Janssen and Moraga-González (2004), Janssen, Moraga-González and Wildenbeest (2005), McAfee (1995), Rauh (1997), Reinganum (1979), Rob (1985), Rothschild (1973), Stahl (1989; 1996), and Stigler (1961). An attempt to provide a comprehensive review of these numerous theories can only be at a sacrifice of great details. Hence, this section will only highlight the overarching points about the theories. Besides, Baye et al. (2006) have extensively covered a good number of these theories and therefore a repetition of their efforts is avoided here.

To begin, even though there are a number of theories subsumed under the heading of search-theoretic, it is still possible to trace the common theme running through these models. To sum it up, all the search-theoretic models emphasize the idea that dispersion occurs as a result of information search cost. That is, the theories maintain that when consumers have to incur search cost in order to obtain additional information on price, then the search cost creates an opportunity for firms to sell the same product at different prices to different consumers, depending on the consumers' willingness and ability to search and find a lower price; or not to search and probably pay a higher price. Within the generality of the search-theoretic models, search cost comprises the "shoe-leather" cost (i.e. opportunity cost of time in searching for low prices) and other costs associated with obtaining price quotes from competing firms (Baye et al., 2006).

Among the search-theoretic models, a distinction can be drawn between two sub-categories: fixed-sample search-theoretic models and sequential search-theoretic models. In fixed-sample size model, the assumption is that prior to embarking on search, consumers decide on a fixed number of searches to be conducted. An example of the fixed-sample size theoretic model is Stigler (1961). In these kinds of models, a critical decision that needs to be taken upfront before a consumer embarks on a search for the lowest price is how many times the search will be conducted. However, in the sequential search models, the assumption is that a consumer first decides on a reservation price (i.e. the maximum acceptable price) and continues to search until he or she discovers the lowest price below their reservation price or until the additional cost of searching just exceeds the marginal benefit of searching (Diamond, 1971; Reinganum, 1979).

In a critique of the fixed-sample size theories, Rothschild (1973) pointed out that the theories ignore the possibility of incorporating information obtained from previous search such as exceptionally low price and therefore could lead to sub-optimal benefits from the search. Morgan and Manning (1985) have also demonstrated that both the fixed-sample size and sequential models can equally generate optimal benefits under different circumstances. Under circumstances where a quick decision needs to be made, Morgan and Manning (1985) consider the fixed-sample size models to be advantageous over the sequential models but where the information searcher seeks to minimize search cost then sequential models are potentially advantageous.

Apart from distinguishing search theoretic models in terms of how search is conducted (fixed sample size or sequential), there are a number of other assumptions that differentiate the various search-theoretic models. For example, Davis and Holt (1996), Diamond (1971), Perloff and Salop (1986), Rothschild (1973), Stahl (1989; 1996), and Stigler (1961) demonstrate that under the assumption of no capacity constraints, dispersion still arises as a consequence of search cost. By contrast, Arnold (2000) shows that if firms have capacity constraints which result in stock-outs during periods of high demand, then price dispersion could still occur because consumers will have to incur search cost to determine whether there is stock or not, and due to that they may adopt symmetric mixed search, which will not necessarily draw them to the lowest-price seller because they might have genuine concerns for the possibility of stock-out.

In sum, while search cost may be useful in explaining price dispersion in some markets (e.g. brick-and-mortar where the search cost could be cost of visiting or phoning sellers or searching individual sellers' websites), it may offer limited explanation in markets where cost of obtaining additional information on prices is almost zero (i.e. frictionless markets). Classic examples of frictionless markets may include price comparison websites (e.g. Kayak.com) and Internet shopbots. For these markets also, a number of alternative theories have emerged to explain price dispersion. This group of theories have been referred to as the information clearinghouse models and are reviewed in the next section.

2.7.2 Information clearinghouse

Information clearinghouse models refer to the theories of price dispersion that recognize the fact that search could be costless in some markets and therefore emphasize the point that price dispersion in those markets may not be caused by marginal search cost. In other words, the information clearinghouse models deemphasize the role of marginal information search cost as the cause of price dispersion in frictionless market. Examples of these theories identified by Baye et al. (2006) include Baye and Morgan (2001), Baye et al. (2004), Narasimhan (1988), Rosenthal (1980), Salop and Stiglitz (1977), Spulber (1995) and Varian (1980). The popularity of information clearinghouse models has been growing in recent times especially after the advent of price comparison websites which serves to provide customers with an easy way of obtaining and processing information from different sellers.

A major conclusion from most of the information clearinghouse models is that, even where consumers can access price information at almost zero costs, price dispersion will still exist because not all consumers will be informed about where to locate the lowest-price seller. In other words, price dispersion will be sustained in a frictionless market because some fraction of the consumers may be informed about the entire price distribution and therefore buy at the lowest price while others may not be informed. In defence of this position, Salop and Stiglizt (1977), for example, showed that when a market consists of informed and uninformed consumers (consumers who know the entire distribution of prices and those who know nothing about the distribution of prices), with the share of uninformed consumers being large enough to keep sellers in business; then price dispersion can be observed as a result of the consumer-heterogeneity. That is, some sellers will be able to sell to the informed consumers at a competitive low price while others will sell at a higher price to the uninformed consumers.

Varian (1980) notes that the persistence of price dispersion in Salop and Stiglizt's model will depend on whether consumers learn from experience or not. If consumers can learn from experience, then the persistence of price dispersion will most probably be unlikely. In an alternative explanation, Varian (1980) therefore argues that when markets have informed and uninformed consumers, sellers can adopt a mixed-pricing strategy of intentionally varying their prices (through sales for example) to prevent consumers from learning about which sellers charge lower or high price so that they can continue to discriminate between informed and uninformed consumers.

In Rosenthal's (1980) and Narasimhan's (1988) models, price dispersion is considered to be the consequence of the fact that consumers may have preferences for some particular sellers. In other words, these theories argue that each firm may have a fraction of its customers to be "loyal consumers" while the others may be "shoppers". The equilibrium price dispersion will therefore result when sellers simultaneously practise a mixed strategy of pricing low to attract shoppers and at the same time maintain high prices for the loyal customers.

2.8 Theories of price adjustments – frequency and pattern of price change

In a competitive market economy, prices are supposed to be determined freely by the interaction between demand and supply. In such a market, the absence of any friction is supposed to allow price to freely adjust in response to changes in market conditions. However, where changes in market conditions require that prices are adjusted upward or downward and sellers are unable to adequately change prices, then economists refer to this situation as price rigidity, price stickiness, price inertia, or price inflexibility (Blinder, Canetti, Lebow & Rudd, 1998; Carlton, 1989). Hence, the factors that may cause prices to become rigid are conversely the factors that may explain the frequency of price change.

Means (1935) provided an influential study to explain the view that prices may become "rigid" because they are administered. Since then, there have been a number of theories to suggest that the frequency of price adjustment (or alternatively, price rigidity) may be associated with price adjustment costs (Carlton, 1986; Kashyap, 1995; Lach & Tsiddon, 1996; Mankiw & Reis, 2002; Sheshinski & Weiss, 1992; Zbaracki, Ritson, Levy, Dutta & Bergen, 2004), market structure (Carlton, 1986; Powers & Powers, 2001), information asymmetry (Allen, 1988; Ball & Romer, 1990; Stiglitz, 1999), demand-based factor (Borenstein, Cameron & Gilbert, 1997; Kashyap, 1995; Sims, 2003; Warner & Barsky, 1995) and contract agreements (Bergen, Dutta, Levy, Ritson & Zbaracki, 2003; Carlton, 1979; Hubbard & Weinner, 1992; Zbaracki et al. 2004). Table 2.2 provides a general overview of the various theories of price rigidities and the specific sources of the inflexibility.

Table 2. 2: An overview of multiple theories of price rigidity

Theories	**Description**	**Source of rigidity**	**Applicable to e-commerce?**	**references**
Cost of price adjustment	Changing price is costly; prices unchanged even with changes in supply and demand	*Menu cost*: Firms face a lump sum cost whenever they change their prices	No	Carlton (1986); Kashyap (1995); Levy, Bergen, Dutta and Venable (1997)
		Managerial cost: time and attention required by managers for price decision may slow down price changes	Yes	Mankiw and Reis (2002); Zbaracki et al. (2004)
		Synchronization and staggering: stores tend to change the price of different products either together or independently	Yes	Lach and Tsiddon (1996); Sheshinski and Weiss (1992)
Market structure	Monopoly power (or limited number of sellers) as well as coordination failure in markets are the primary sources of price rigidity	*Industry concentration*: the sluggishness of price changes is a demonstration of monopoly power	Yes	Carlton (1986); Powers and Powers (2001)
		Coordination failure: absence of an effective coordination mechanism for market clearing because of the price rigidity	Yes	Andersen (1994); Rotemberg and Saloner (1990; 1986)
Asymmetric information	The fact that one part to a transaction has more information provides an explanation	*Price as signal of quality*: firms are reluctant to lower prices for fear that their customers may misinterpret prices cuts as reduction in quality	Yes	Allen (1988); Stiglitz (1987)
		Search and kinked demand curve: customers search costs lead to firms facing a kinked demand curve	No	Ball and Romer (1990); Stiglitz (1999)
Demand-based	Firms react to other changes than price changes; inventories and non-price competition	*Procyclical elasticity of demand*: demand curves become less elastic to price changes as they shift in		Rotemberg and Saloner (1986); Warner and Barsky (1995)
		Inventories: inventories are used by firms to buffer demand shocks	No	Amihud and Mendelson (1983); Borenstein et al. (1997)

		Psychological pricing: prices have the tendency to be stuck at certain ending prices	Yes	Kashyap (1995); Sims (2003)
		Non-price competition: instead of price competition, firms use non-price elements such as delivery lags, services, or product quality	Yes	Carlton (1983); Okun (1981)
Contract-based	Price remains unchanged because firms and customers enter into explicit or implicit contracts	*Explicit contracts*: prices are fixed for limited periods under nominal contracts	No	Carlton (1979); Hubbard and Weiner (1992)
		Implicit contracts: as price changes may antagonize customers, implicit agreements between firms and customers are used to stabilize prices	Yes	Bergen et al. (2003); Okun (1981); Zbaracki et al. (2004)

Source: Adapted from Kauffman and Lee (2007, p.9 & 39)

As shown in Table 2.2, some of the price adjustment theories originating from the offline market can also be applicable to the digital economy. Kauffman and Lee (2007) have accordingly identified the applicable theories (refer to 4th column in Table 2.2). In the subsequent sections, the applicable theories are reviewed briefly.

2.8.1 Managerial cost of price adjustment theory

Before prices are adjusted, time and other resources are spent to analyse the pros and cons of changing the price. The theory of managerial cost, also known as hierarchy theory, assumes that firms cannot change prices promptly in response to changes in market situation, especially if many individuals' decision in a hierarchical organization are required to process and effect a price change (Bergen et al., 2003; Blinder et al., 1998). According to Zbaracki et al. (2004), the managerial cost of changing prices may include information-gathering costs, decision-making costs, and internal communication cost. The information-gathering cost may include customer, company and competitor data and process may involve many different members within and outside of the organization. Once prices are changed, a subsequent cost arises in term of time and efforts needed by managers to communicate the new prices to the sales force and getting them to understand how the new prices will in turn be communicated to external customers.

2.8.2 Price synchronization and staggering theory

New Keynesian economists assume that firms change prices step-by-step over time (i.e. staggering over time) and not simultaneously. The adherents of this theory (Lach & Tsiddon, 1996; Sheshinski & Weiss, 1992; Taylor, 1980) believe that, in an oligopolistic markets, each firm takes into account the actions of its competitors, and thus, pricing policies will be interdependent, preventing the firm from changing its prices. Price synchronization is also proposed by Ball and Cecchetti (1987), who developed a model in which firms have imperfect information on the current state of the market and obtain information by observing the prices set by others. This reasoning suggests that a firm will not have an incentive to adjust their prices until other firms initiate the process.

2.8.3 Market structure

In many industries, pricing strategies are interdependent because each firm takes into account the actions of its competitors. Economists have therefore emphasized that the frequency of price adjustment or price rigidity should be dependent on market structure (Dixon, 1983; Ginsburgh & Michel, 1988; Qualls, 1979). However, due to the difficulty in categorizing real-world markets into the four main market structures (i.e. perfect competition, monopolistic competition, oligopoly and monopoly), researchers often adopt measures of competition such as market concentration ratios and seller density to measure degree of competition or market power. Empirical works investigating the relationship between competition and price rigidity have generated three different observations: a) positive relationship; b) negative relationship and c) no significant relationship.

The notion behind the positive relationship is that highly-concentrated markets behave like oligopolies, in which case it can be expected that firms will react differently to price increase (by not following) and decreases (by matching) (Sweezy, 1939). As claimed by Stigler (1964), the justification for a negative relationship could be that in markets with fewer competitors, it is relatively easier for other competitors to identify secret price cutting, hence firms may avoid it. The third perspective (i.e. no significant relationship) is based on the argument that without perfect monopoly or explicit price collusion, firms tend to behave as price competitors and the degree of market concentration becomes inconsequential (Qualls, 1979).

2.8.4 Quality signalling theory

Quality signalling theory is one of the several theories that fall under asymmetric information theories (i.e. different parties to a transaction, for example, buyer and seller, may have different information). Under asymmetric information, Stiglitz (1979) argues that customers will tend to transact with firms providing stable price paths and avoid firms which make frequent and/or large price adjustments. For many products, it is difficult for customers to observe the quality of the products directly even at the time of purchase because they are imperfectly informed about the product characteristics (Stiglitz, 1987). Under normal circumstances, most people tend to believe that high-priced products signals high quality. As a result, firms may have an incentive to keep their prices stable or raise them more easily than they will decrease them so as to signal to their customers about the average quality of their products (Riley, 1989). Although this theory may apply to certain products, its relevance appears to be limited to luxury product markets, where firms are reluctant to lower their prices for fear that customers may incorrectly interpret the lowering of the price to mean reduction in quality.

2.9 Framework for analysing firm behaviour and market outcomes

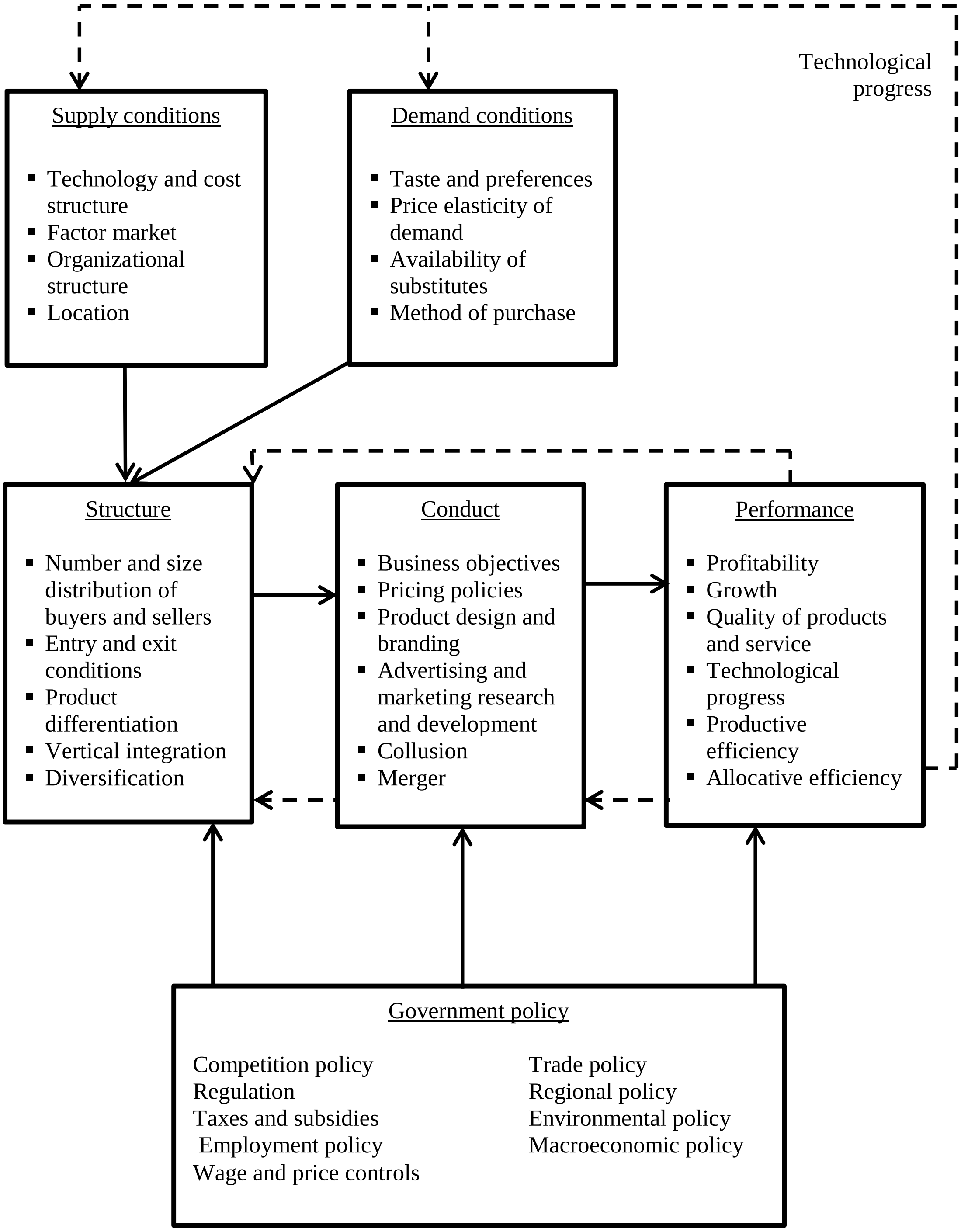
The question of what influences firm's behaviour and market outcomes has long engaged the attention of economists and strategists. Seminal contributions to this subject can be traced back to Mason (1949; 1939), Bain (1951) and Porter (1985; 1980). The contributions of Mason and Bain are credited with the Structure-Conduct-Performance (SCP) paradigm which has dominated the field of industrial organisation for many decades while Porter's contributions have yielded the Porter's Five Forces in the field of strategic management. Both frameworks are useful for analysing the impact of the industry environment on firm behaviour or strategy.

However, in addition to linking the industry's environment to firm behaviour, the SCP provides a basis for linking firm behaviour to market outcomes as well. By establishing linkages among market structure, firm conduct and performance, the SCP suggests what can be done to improve conduct and performance. In more detail, Caves (2007), Lipczynski, et al. (2009) and Schmalensee (1988) provide further explanations on the usefulness of the SCP. The next section outlines the SCP theory.

2.9.1 An outline of the structure conduct (SCP) performance theory

As pointed out briefly in Section 2.9, the structure conduct performance (SCP) theory is widely recognized as a useful and efficient theory for analysing industry performance and conduct of firms within an industry. Generally, the theory stipulates that there are causal relationships among three components of an industry: structure of the industry/market, conduct of firms within the market and performance of the firms. In its original form, the theory hypothesizes that there is a unidirectional causal relationship from the structure to conduct to performance. In other words, the original SCP theory asserts that the performance of an industry is influenced by the conduct (or behaviour) of firms in the industry, which, in turn, is influenced by the structure of the industry.

Over time, as the theory matured through empirical testing of the relationships, reverse causal relationships from performance to conduct to structure were acknowledged and incorporated into the original theory. A schematic presentation of the modified SCP is given in Figure 2.1. In this figure, the solid lines represent the traditional SCP, in which the hypothesized causal relationships are unidirectional. The broken lines show reverse causality that accommodate the criticisms that causality in the SCP framework could be a two-way process.



Adapted from: Lipczynski et al. (2009, p. 7)

Figure 2. 1: Structure conduct performance framework

As depicted in Figure 2.1, the structure of an industry is described by a wide range of characteristics, including the number and size distribution of buyers and sellers, entry and exit conditions, product differentiation, vertical integration and diversification. In turn, these characteristics are influenced by demand and supply conditions in the market, which include price elasticity of demand, availability of substitutes, technology and cost structure, organisational structure and location. In the long term, the structural characteristics of an industry may be expected to be variable; but for static or short run analysis, they are largely considered to be fixed.

Still within the SCP paradigm, conduct is defined as the overt or covert behaviour of firms, conditioned on the structural characteristics of the industry (Lipczynski et al., 2009). By this definition, it implies that conduct depends on the structure of a market and it involves behaviours pertaining to the objectives of the firms, pricing policies/strategies, product designing and branding, advertising and marketing, research and development, collusion/alliances and mergers.

Performance is generally conceived to be outcome(s) that are intended and desired by a firm and for which the firm is committed to achieving. In reality, it is difficult to catalogue a list of all the outcomes that are desirable for firms because the objectives of firms may differ. This notwithstanding, from the SCP framework presented in Figure 2.1, performance commonly refers to outcomes such as profitability, growth, quality of products and services, technological progress, productive and allocative efficiencies.

Besides the central theme of SCP which presents relationships among structure, conduct and performance, the framework also provides tangential arguments to support possible relationships between supply conditions and market structure;

demand conditions and market structure; government policy and the three key variables; structure conduct and performance. Worthy of note is also the fact that, although the SCP paradigm draws heavily on microeconomic theory and the neoclassical theory of the firm, it does not always specify the precise relationship between structure, conduct and performance variables. For this reason, a great deal of attention has been devoted to the empirical testing of some of these hypotheses.

2.9.2 Application of the SCP theory to non-hospitality and tourism industries

A more useful way to summarize the extensive empirical literature on the application of SCP is to categorize the studies into two major groups. The first group of studies tests the SCP paradigm using data from multiple industries (i.e. inter-industry studies) and the second group focuses on the application of SCP in a single industry (intra-industry studies). In the earliest period of the SCP paradigm, most of the empirical studies sought to test the hypothesized relationship among structure, conduct and performance variables and therefore employed data from different industries (Martin, 2012; Pan, 2005). As early as the 1970s, Weiss (1974) provided a comprehensive review of over 40 inter-industry studies conducted on SCP. The conclusions reached from Weiss' (1974) survey were that most of the studies supported a positive relationship between concentration (a measure of structure) and profitability (a measure of performance) and that there was the need for SCP studies to focus more attention on intra-industries.

Three decades after Weiss' (1974) survey, Einav and Nevo (2006) observed that there has been a tremendous growth in intra-industry studies. The authors note that the studies focused on combining economic theories with statistical techniques to analyse the strategic interaction between firms in the same industry. Among the numerous industries that have gained the attention of researchers, the manufacturing sector

(Caloghirou, Protogeru, Spanos & Papagiannakis, 2004; Chang & Singh, 2000), banking sector (Bourke, 1989; Chirwa, 2003; Molyneux & Thornton, 1992), airline (Berry & Jia, 2010; Goolsbee & Syverson, 2008; Morisson, 2001), insurance (Bajtelsmit & Bouzouita, 1998) and supermarkets (Bonanno & Lopez, 2009; Hausman & Leibtag, 2007; Smith, 2004) appear to be the most widely researched areas. Out of the generality of the intra-industry studies, the conclusions are that the more competitive an industry is, the more competitive the firms' conduct are and the better the market performance (Martin, 2012).

2.9.3 Application of the SCP theory to tourism and hospitality industries

Unlike other service industries such as banking and insurance, the application of SCP in tourism studies has rather been limited. The main reasons for this paucity of empirical studies have been attributed to the lack of readily available data and the challenges of defining the boundaries of the industry (Davies, 1999). Nevertheless, some notable studies have been conducted mainly in the package tour business (Baum & Mudambi, 1994; Curtin & Busby, 1999; Davies & Downward, 1998; Evans & Stabler, 1995; Sheldon, 1986; Taylor, 1996). Most of these studies utilized the SCP framework to explore the structural characteristics of the package tour business and to evaluate the competitiveness or contestability of the sector.

The conclusions reached from these studies have been mixed. For example, in the empirical analysis of the US package holiday industry, Sheldon (1986) concludes that the industry is contestable because there were many small firms dominating the industry. In the UK, Baum and Mudambi (1994) argue that the industry is oligopolistic while Taylor (1996) argues the market is contestable. In Germany and UK, Aguiló, Alegre and Sard (2003) find that the market for package tour industry is oligopolistic.

In the hotel sector, a relatively large number of studies have also applied the SCP framework. These studies have focused on the application of SCP to investigate hotels' pricing policies (Baum & Mudambi, 1995; Chung, 2000), profitability (Davies, 1999; Matovic, 2002; Molina-Azorin, Pereira-Moliner & Claver-Cortés, 2010; Pan, 2005) and efficiency (Assaf & Magnini, 2012; Barros, 2006; Barros & Santos, 2006; Chen, 2007; Hu, Chiu, Shieh & Huang, 2010; Oliveira, Pedro & Marques, 2013). Table 2.3 provides a summary of selected studies in the hotel industry applying the SCP framework.

Table 2. 3: Summary of hotel industry studies applying the SCP

Author(s)	Country	Dependent variable	Independent variables	Summary of major findings
Davies (1999)	UK	Return on sales	Market concentration, market share, unemployment	Although the results could be sensitive to the choice of econometric model and definition of industry, there is evidence to show that the UK hotel sector is oligopolistic instead of competition or contestable market. In addition, market concentration has negative effect on hotel profitability
Matovic (2002)	US	Earnings	Market share, barriers to entry, company growth rate, competition (number of competitors)	The US lodging industry is more competitive, and the competitive market structure constructs of barriers to entry, market share, growth and concentration have significant but differing effects on financial performance.
Pan (2005)	Taiwan	Accounting Profit	Market concentration, location	Market concentration has a positive effect on hotel profitability. In addition, profitability is determined by the location of hotels
Barros and Dieke (2008)	Angola	Efficiency score	Market share, group membership, international expansion strategy	Efficiency was increasing at decreasing rate over the study period. Hotel's membership in a group, hotels with an international strategy and higher market share improves technical efficiency
Molina-Azorin et al. (2010)	Spain			The study determines the relative importance of location or destination effect and firm effect on tourist firms. While both destination and firm effects are important explainers of firm performance, firm effect is more important than destination effect.
Oliveira et al. (2013)	Portugal	Efficiency score	Star rating, golf courses and location	The study investigates the influence of star rating, golf courses and location on efficiency and found that only location and the existence of golf courses determine efficiency.

As one of the pioneers to have applied the SCP framework to the hotel industry, Davies (1999) underscored the relevance of the SCP to the hotel industry and expressed surprise that the framework had little to offer on the hotel industry. In his words, Davies (1999, p.296) stated that "…it is surprising the IO literature has little to say on this area of economic activity". Contributing to the application of SCP to the hotel industry, Davies (1999) applied econometric techniques to analyse the market structure of the UK hotel industry and found that the industry was oligopolistic rather than competitive or contestable. His analysis also revealed that, contrary to the findings of most SCP studies in other industries, the UK hotel sector showed a negative relationship between market concentration and hotel's profitability.

In a critique of Davies' (1999) study, Pan (2005) observed that location of hotels is an important variable influencing the success or otherwise of hotel business and that this variable was overlooked in Davies' study. In addition, Pan (2005) considered it to be worthy and appropriate to use room sales to measure market concentration as opposed to total sales, which was used in Davies's study. Pan's (2005) argument was that using total sales could have influenced the relationship since total sales includes revenue from other services provided by hotels. Taking these limitations into account, Pan (2005) presented contradictory evidence to Davies' (1999), whereof market concentration had positive effect on hotel's profitability and location was also found to be a significant determinant of profitability.

Applying the SCP framework to the US lodging market, Matovic (2002) found that the lodging market was at a mature stage of its lifecycle and that the structure was more competitive. In his application of the SCP, Matovic (2002) proposed a modified

SCP — referred to as Lodging Market Structure (LMS) — to determine the influence of four lodging market structure constructs, comprising barriers to entry, competition, growth and market share, on financial performance. The findings indicated that among the four market-structure constructs, barriers to entry have the greatest negative impact on financial performance, followed by competition. Growth of brand as well as improvement in brand's market share was found to have a positive influence on financial performance. In another study of the US lodging market, Kalnins (2006) also found that there were characteristics in the lodging market to show that it was indeed competitive.

While a number of studies have applied the SCP framework to the hotel industry, it is important to point out that most of the applications have been testing through-and-through the SCP hypothesis from structure to performance, with limited studies focusing on the relationship between structure and conduct (Baum & Mudambi, 1995; Chung, 2000). This dearth of studies on structure-conduct nexus could probably be attributed to the lack of extensive data on pricing or the fact that hotel business are more concerned with the bottom line—profitability and efficiency.

In departure from the earlier studies, this study will use the SCP framework to analyse the effects of market structure variables on online pricing behaviour rather than test the effects of market structure on profitability or efficiency as has been done in most previous studies (Assaf & Magnini, 2012; Barros, 2006; Barros & Santos, 2006; Chen, 2007; Davies, 1999; Hu et al., 2010; Molina-Azorin, et al., 2010; Oliveira et al., 2013).

2.9.4 *Criticisms of the SCP theory/paradigm*

Like many other theories, the SCP has survived the test of time, after facing some initial criticisms. Some of the criticisms, especially the critique that a number of the conduct and performance variables have feedback effects on structure, had led to a paradigmatic shift from the traditional unidirectional SCP to SCP that incorporates reverse causality. Other criticisms of the SCP have been highlighted by Lipczynski et al. (2009) as follows: a) difficulty in deciding which variables belong to structure, conduct and performance; b) problem of defining performance due to differences in the objectives of firms; c) difficulty in measuring many of the variables which describe structure, conduct and performance and d) overemphasis on static or short-run equilibrium analysis, without explanation on the evolution of structure variables and the influence of current conduct and performance on the future structure.

Notwithstanding the above criticisms of the SCP, which are largely identification and measurement problems, the framework has continued to enjoy wide application till date due to its superiority. In the present study, the above criticism will not apply because of the following reasons. First, this study does not seek to test the relationship among the three components of the framework (i.e. structure, conduct and performance) and therefore the difficulty of deciding which variables belong to which component does not necessarily arise. Moreover, the objectives of this study clearly state the components of online price behaviour that are going to be studied. Second, since the study is also not testing the relationship between market structure and performance, the second criticism does not also apply. Lastly, the variables measuring the structure of the hotel market are derived from the extensive literature, and therefore do not present any measurement difficulty.

The next section of the literature review is devoted to describing the market structure of the hotel industry so as to provide an understanding of the relevant characteristics of the industry that may have influence on online pricing behaviour of hotels.

2.10 Market structure of the hotel industry

Scholars in the field of economics use the term market structure to describe the set of characteristics that distinguish one type of a market from another (Bain, 1956; Clark, 1940; Lipczynski, et al., 2009; Scherer & Ross, 1990; Shepherd, 1972). In traditional microeconomics, the neoclassical theory of the firm identifies four different types of market structures; namely, perfect competition, monopolistic competition, oligopoly and monopoly. In simple terms, these four markets can be considered to be on a continuum from most competitive market to the least competitive whereby perfect competition and monopoly are at the two extreme ends of the most competitive and the least competitive respectively. Monopolistic competition and oligopoly are the intermediary markets located between perfect competition and monopoly. Thus, both monopolistic competition and oligopoly markets can be regarded as possessing the combined features of perfect competition and monopoly.

To distinguish among the forms of markets, economists usually examine the characteristics of the markets in the light of: a) the number and size distribution of sellers;

b) the extent of barriers to entry and exit; and c) the degree of product differentiation (Bain, 1956; Clark, 1940; Lipczynski, et al., 2009; Scherer & Ross, 1990; Shepherd, 1972). Other attributes can be considered for the purposes of distinguishing among the various types of markets; however, most economic textbooks present these three as the most important ones (Lipczynski et al., 2009; Shepherd, 1972). Table 2.4 illustrates how the four theoretical models of market structure compare to each other, using the essential elements or characteristics of market structures.

Table 2. 4: Comparison of the four models of market structure

Market Structure	***Number of sellers***	***Freedom of entry and exit***	***Nature of product***
Perfect competition	Large/infinite	High	Identical
Monopolistic competition	Many	Medium/high	Similar/slight difference
Oligopoly	Few	Low	Same/slight difference
Monopoly	One	Blocked	Unique

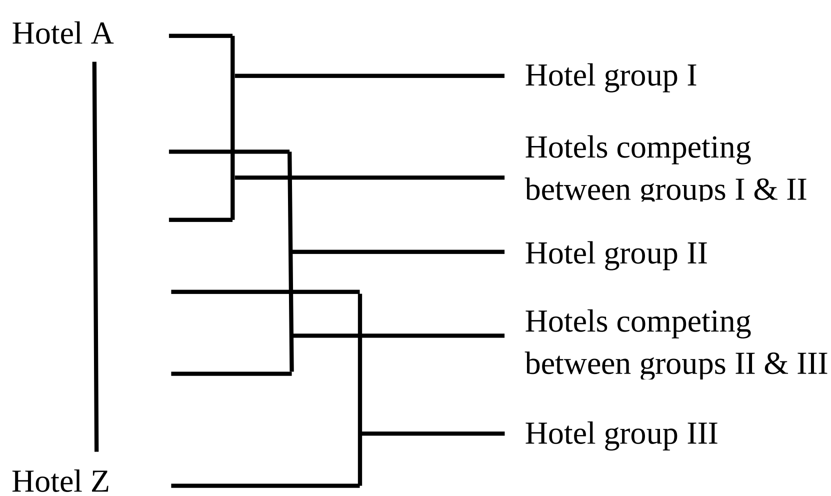
As presented in Table 2.4, perfect competition is a market with a large number of buyers and sellers, selling homogenous product at a uniform price without any barriers to entry or exit from the market. In contrast, a monopoly market is a market with a single seller that has the power to control either the market price or quantity in order to maximize profit. In monopolistic competition, there are many sellers who tend to compete with one another, but the sellers do not recognize that they are interdependent. Oligopoly markets on the other hand are characterized by few sellers of differentiated or homogeneous products who recognize their mutual interdependence and therefore either choose to compete in terms of quantity or price or collude to avoid competition.

From the foregoing descriptions of the four types of market structures, it appears obvious that the structure of the hotel market in general is neither a monopoly nor a perfect competition. Indeed, these two extreme types of market rarely exist in practice, but economists still study them because there are markets that come close to sharing their features. Having concluded that the hotel industry is neither a perfect competition nor a monopoly, it is not apparent whether the industry is monopolistic competition or oligopoly. Some authors have considered the market to be oligopolistic (Baum & Mudambi, 1995; Chung, 2000; Davies, 1999) while others maintain that it is monopolistic competition (Ellerbrock, Hite & Wells, 1984).

The main contention between the two divide has been in terms of how broad or narrow a market should be defined and the level at which the market analysis is to be conducted—macro level analysis or micro level analysis. For researchers seeking a macro-level analysis, it is customary to assume that the hotel market structure is monopolistic competition, in which case, all the “many sellers” of hotel products within a certain jurisdiction are considered to be competitors by virtue of the fact that their products are similar. But for authors seeking a micro-level analysis, an oligopolistic market structure is usually considered to be a more realistic assumption of the hotel industry.

Even though the macro perspective of studying the market structure of the hotel industry can still be regarded as a good approximation of the reality, researchers in industry substructures (Hatten & Schendel, 1977; Ulrich & McKelvey, 1990), strategic groups (Boeker, 1991) and firm size distribution (Baum & Mezias, 1992; Ranger-Moore, Breckenridge & Jones, 1995) warn of the negative consequences of adopting such an approach. They contend that, in any given industry, not all the firms in the industry may be competing with one another for the same scarce resources or demand or even contributing to or experiencing competition equally. Thus, to consider all existing firms in an industry as competitors, as required under monopolistic competition, can be at a great compromise of some pertinent details about the true extent of competition.

Advancing similar arguments for the hotel industry, Chung (2000) provides a hypothetical illustration (see Figure 2.2 and Table 2.5) to suggest that the market structure of the hotel industry can best be conceptualized as oligopolistic market structure, where competition is formed within similar product classes and similar customer classes or types.



Source: Adopted from Chung (2000, p.137)

Figure 2. 2: Conceptual market structure of the hotel industry

Table 2. 5: Hypothetical hotel rankings and demand types

Hotel ranking	Demand type
H_1	D_1 D_2 D_3
H_2	D_2 D_3 D_4
H_3	D_3 D_4 D_5
H_4	D_4 D_5 D_6
H_5	D_5 D_6 D_7

In Figure 2.2, the information presented shows that although a hotel market may consist of many hotels, a clustering of the hotels into sub group based on their shared characteristics could be identified. Perhaps, the existing practice in the hotel industry whereby hoteliers identify some hotels as either their primary competitors or secondary competitors lends a practical support to Chung's (2000) argument.

Table 2.5, which is provided to accompany the hypothetical groupings in Figure 2.2, indicates that, when considered from the demand side, the various hotel groups could be serving different segments of the market which are not necessarily distinct or non-overlapping; but a hotel group can be competing in more than one market segment. For example, as shown in Table 2.1, hotel H_1 and H_2 may be competing for D_2 and D_3 and not D_1 and D_4. Similarly, H2 and H_3 may also be competing for D_3 and D_4 and so on.

In view of the purpose of this study and the benefit of richness in analysis, a micro-level perspective of online pricing behaviour will be conducted. For this reason, it appears more appropriate to follow the assumptions of an oligopolistic market structure. In this sense, this study will proceed in a similar line as Chung (2000) and other authors (Baum

& Mudambi, 1995; Davies, 1999) to consider the competitive market structure of the hotel industry as comprising groups of identical hotels in a localized market within which frequency of price change, pattern of price change and magnitude of dynamic price dispersion will be analysed. By proceeding along these lines, it becomes possible to examine the microstructure of each group to ascertain the extent of localized competition and spatial heterogeneities within various market locations and their influences on pricing behaviour. In the next section, 2.11, the specific factors to be examined under oligopolistic market structure are presented together with other factors that have been identified as possible influencers of online pricing behaviour.

2.11 Possible factors influencing online pricing behaviour

As indicated previously, the ultimate goal of this study is to analyse the factors influencing online pricing behaviour. Therefore, deriving from the theoretical literature on price dispersion and the structure conduct performance theory, a number of factors can be identified as potential influencers of online pricing behaviour. From the perspectives of sellers, these factors may be categorized into three broad themes, including market structure variables, product characteristics, and location characteristics. Similar categorizations have been adopted in airline studies (see Borenstein & Rose, 1994; Gerardi & Shapiro, 2009; Gillen & Mantin, 2011; Hayes & Ross, 1998; Obermeyer et al., 2013).

By focusing on these broad factors, it is not being asserted that these are the only factors that may influence online pricing behaviour. Rather, it is argued that, as far as the magnitude of price dispersion, the frequency of price change and the pattern of price movements are concerned, market structure, hotel characters and location attributes may be the important influencing factors on the side of hotel room suppliers. In identifying these three broad factors, the market structure variables are derived from the SCP theory while product and location characteristics are derived from the variety of price dispersion theories emphasizing seller heterogeneities. Consistent with Abrate et al. (2012), consumer heterogeneities will be captured implicitly when the data are analysed in terms of the day (Weekday or Weekend) when booking is supposed to be made.

2.11.1 Market structure variables

The relationship between market structure and online pricing behaviour is not farfetched. It is derived from the SCP theory, which hypothesizes a causal relationship between market structure and conduct of the firms, including pricing (Bain, 1951). In the airline industry, Borenstein (1985) and Holmes (1989) have shown that differentiated oligopoly market structure can exhibit higher price discrimination and dispersion than monopoly markets. In the hospitality literature, Balaguer and Pernías' (2013) demonstrated that consistent with the predictions of monopolistic models; higher seller density (a measure of market structure) lowers average price and dispersion of local prices. While a relationship between market structure and conduct cannot be contested, it is still an open question whether a single variable can be used to measure or proxy market structure.

In industrial organisation literature, there are several factors that can be used to measure or determine market structure. These factors include number and size distribution of sellers, extent of barriers to entry or exit and product differentiation (Lipczynski, et al. 2009; Shepherd, 1972). Ultimately, the market structure variables, combined together, are supposed to define the extent of competition in a market and therefore, in most practical studies, the single most important measure of market structure is considered to be the level of competition. However, competition itself remains a multidimensional concept, and its measurement may also not be straightforward.

Clark (1925, p.220) defined competition as “rivalry for income by method of giving more than one’s rivals give in proportion to what one asks in return, or by making the public think so, or by making them at least act as if they thought so to the extent of buying one’s goods in preference to those of one’s rival”. In the context of market structures, Smith (1937) expressed the view that competition connotes two broad conceptions: one which is based on the conduct of buyers and sellers and the other which is based on market structure. On the conduct side, Smith considers competition to be an independent striving for patronage by the various sellers in a market. But in terms of structural conceptualization, Smith considers competition to be an outcome of a market characterized by large number of firms selling homogenous product with the size of each firm being insignificant relative to the entire market such that no individual firm by itself is able to affect the price of the product.

The relationship between competition and market structures seems to be well-understood from the industrial organisation theory. However, the measurement of competition still remains an area of contention. Several measures of competition have been suggested in the literature, including average number of sellers, the reciprocal of firm numbers, seller concentration ratio, Herfindahl-Hirschman Index (HHI), Gini coefficient and the entropy index, the Euclidean distance around a focal firm (Pan, 2005). Among these indices, the most popular and widely used index in empirical research is the HHI. This index measures the market concentration by using information on all the market shares of the sellers. Simply, the HHI is the sum of the squared market shares of all the firms in the market. This measure of competition is regarded as a superior index to all other indices because it takes into account both the number and size distribution of all the firms in the market.

For a micro-level analysis, the application of any of these indices requires a clear definition of the geographical market in order to be able to measure competition at the localized level. Going by the works of Baum and Mezias (1992), Hannan and Ranger-Moore (1990) and Hannan, Ranger-Moore and Baaszak-Holl (1990), localized competition can be measured based on the Euclidean distance of a focal organisation to other organisations within a radius of x-distance around the focal firm, a measure similar to those commonly used in the networks literature (Blau, 1977; Marsden, 1987; McPherson, 1990; McPherson & Ranger-Moore, 1991). This measure serves to weight competing organisations according to their proximity to the focal organisation in the distribution on a given organisational dimension.

2.11.2 Location characteristics and spatial agglomeration

Undoubtedly, location is one of the important attributes widely accepted among researchers as the foremost characteristic that impacts on the business of a hotel (Balaguer & Pernías, 2013; Becerra, Santaló & Silva, 2013; Bull, 1994). Frequently, location is cited as one of the factors that travellers consider in their decision to purchase hotel accommodation (Wyckoff & Sasser, 1981). Sasser, Oslen and Wyckoff (1978) emphasize that location influences customers' purchase decision because, unlike other industries where a product can be purchased at one location and transported to another location for consumption, hotel products must be consumed at the same location that they are produced. Hence, as part of the attributes of hotel products, location characteristics are integral and may become a source of differentiation for premium or discount pricing.

Several researchers have also examined the significance of location in a hotel site selection and have developed different models in economics (Kalnins & Chung, 2004), marketing (Baum & Haveman, 1997; Urtasun & Gutiérrez, 2006) and geography (Egan & Nield, 2000; Shoval, 2006) to explain its importance. To emphasize the strategic importance of the uniqueness of certain hotels' location, names like airport hotel, beach hotel, lakeside hotel, countryside hotel among others are usually embedded in the identity of hotels as a differentiation variable. In some jurisdictions, the hotel classification system takes into account the importance of location by assigning different weights to different locations, with hotels in vantage locations obviously having higher points than those in less-attractive places (an example is the HKTB hotel classification system).

It is also believed that, the location of a hotel can determine the clientele of the hotel and subsequently the room rates it charges (Egan & Nield, 2000; Shoval, 2006). For example, hotels in the vicinity of airports are known to offer high accessibility to airports and are therefore likely to cater to the needs of businesspeople and travellers who may anticipate late arrivals, overnight transfers and early departures (Lee & Jang, 2011). Molina-Azorin et al. (2010) also argue that hotel revenue performance and occupancy rates can be explained by location. The authors estimated that up to about 31.5% of the variance in revenue performance can be determined by location. Several other authors have also linked room rates directly to location (Andersson, 2010; Becerra et al., 2013; Chen & Rothschild, 2010; Lee & Jang, 2011; Monty & Skidmore, 2003; Thrane, 2007; 2005).

In an influential article on *Stability in competition,* Hotelling (1929) articulated the role of location in spatial competition. In his analysis, Hotelling (1929) argues that purchasers of a commodity may choose to buy from different competitors in spite of moderate differences in prices because different locations may impose different "transportation cost" on buyers. Thus, for an identical product sold by different competitors in different locations, consumers will rationally choose to buy from sellers located nearest to them so that they can minimize the transportation cost. In other words, each seller in a distinct location has some market power over price and can exercise this market power to charge a slightly higher price insofar as the higher price does not make it economical for buyers to shift to the lowest-price seller.

Although Hotelling's (1929) location theory was not directly aimed at linking location to room rates, it does offer significant insights into how location can make otherwise identical goods become differentiated and therefore provide an explanation why prices may be dispersed. As Hotelling (1929) notes, the slight difference in prices that purchasers are willing to tolerate may be related to the fact that consumers save some money on transportation by buying from the nearest location. Applying this notion to hotel business, a location's proximity and convenient access to points of tourist attractions or business activity will be important to hotel guests and therefore afford some hotels an urge to charge a premium price which may create price dispersion (Baylis & Perloff, 2002; McMillan & Morgan, 1988; Sutton, 1980). Another important way by which location is related to price dispersion is through spatial agglomeration effect. Naturally, hotels tend to cluster around geographically attractive places and the local competition that accompanies the agglomeration of the sellers can influence pricing (Balaguer & Pernías, 2013).

In quite a number of empirical studies, different attributes of location have been shown to have an impact on room rates and the influences of these characteristics can be extended to hotels' own pricing behaviour. Abrate et al. (2011) as well as Lee and Jang (2011) divide the essential location characteristics into location-attractiveness attributes or location-accessibility. Basically, location-attractiveness attributes refers to the man-made or artificial characteristics of a location that make some segment of customers drawn to that location over other locations. Examples include distance to central business district and/or artificial and manmade attractions such as mountains, beach, and shopping area (Andersson, 2010; Becerra et al., 2013; Carvell & Herrin, 1990; Thrane, 2005).

Location-accessibility attributes on the other hand, refers to the mechanisms in place that make a location easily reachable. Typical indicators of accessibility include distance to airport, distance to the nearest interchange or train station (Balaguer & Pernías, 2013; Thrane, 2007; Zhang, Zhang Lu, Cheng & Zhang, 2011). In terms of pricing, the more favourable a location is in terms of attractiveness and accessibility, the more likely its prices are going to be dispersed, exhibit higher frequency of price change and possibly show an increasing price pattern over a given booking period. This argument is based on the fact that the more favourable a location is the more likely it will attract guests which could render demand unstable.

Existing studies in Geography (e.g. Egan & Nield, 2000; Shoval, 2006), marketing (e.g. Baum & Haverman, 1997; Urtasun & Gutiérrez, 2006) and economics (e.g. Kalnin

& Chung, 2004) have argued that due to the strategic importance of location in hotels' business, there is a natural tendency for hotels to agglomerate or cluster around each other or some attractive locations, leading to spatial competition. As part of the reasons for the clustering of firms, spatial agglomeration theory has suggested two types of benefits that can be derived from locating near competitors: production economies and demand-related benefits (Canina, Enz & Harrison, 2005; Marshall, 1920; Urtasun & Gutiérrez, 2006).

Much of the research that has investigated agglomeration economies has focused on the production externalities of increased access to specialized inputs, specialized labour, and knowledge spill-overs. In general, production externalities are often most relevant in manufacturing and high-technology industries, while demand externalities are more relevant in retail and consumer service industries. These firms require fewer specialized inputs and labour, and technical knowledge is less critical, leaving a reduced role for knowledge spill-overs. The interest of this study in pricing behaviour suggest a focus on demand-side externalities.

According to Marshall (1920), businesses may cluster together for the convenience of customers since the clustering can aid buyers by reducing their search cost. In other words, geographical concentration of firms can facilitate the discovery and evaluation of the variety of options available from multiple firms (Stahl, 1982; Stuart, 1979). This type of benefits are particularly salient when product traits require visual inspection by consumers (Stahl, 1982) and when product heterogeneity is high (Fischer & Harrington, 1996). For firms that sell products or services that must be consumed at its location of production, Canina et al. (2005) have identified a separate demand-related benefit from agglomeration, an effect they refer to as "differentiation spillover" (p.567).

According to them, firms who sell products or services that are consumed at the firms' location may benefit from the investment of competitors that make a location more attractive (e.g. external landscaping or area infrastructure) since location-based investment are not always firm-specific and hence can spillover to the benefit of all the firms in a particular geographic location. Thus, firms can copy differentiation investments of their competitors at a lower cost. By extending these arguments to pricing, it means that spatially agglomerated firm can be expected to price their products/services based on the pricing behaviour of their competitors.

2.11.3 Hotel and product characteristics

To an extent, hotel characteristics give an indication of the actual and perceived quality of services offered by hotels. This makes pricing unavoidably dependent on hotel characteristics. As argued by Rosen (1974), the price of a composite good or service consists of all the implicit prices of the utility-bearing attributes of the good or service. A substantial body of literature has confirmed that certain attributes of hotels, including room attributes, have an influence on room rates. These attributes can be summarized into either reputation-based (non-physical including service) attributes or facilities and amenities.

A provision of the full list of all the relevant attributes of a hotel that may affect room rates is almost impossible due to the constant change in technology. However, an attempt has been made by Kisilevich, Keim and Rokach (2013) to provide a comprehensive list of some of the attributes (see Table 2.6). Among these, the prominent ones that have been utilized in empirical studies include star rating, chain affiliation or brand name, ownership and management, online reviews, room sizes and equipment, product offerings, facilities and amenities (Bull, 1994; Monty & Skidmore, 2003).

Table 2. 6: List of hotel-related attributes for pricing analysis

Facilities	Amenities	Other
Air condition	24-our front desk	Number of rooms
Satellite TV	Babysitter services	Hotel category
Hairdryer	Baggage hold	Hotel name
Iron & ironing board	Barber/beauty salon	Standard room rate
Mini bar	Breakfast room	Waterfront
Clock-radio	Café	(derived attribute)
Private bath	Car rental desk	
Refrigerator	Children care/activities	
In room safe	Coffee shop	
Telephone	Concierge	
Fully equipped kitchen	Conference room(s)	
Microwave	Currency exchange	
Wake-up service	Dry cleaning service	
Internet access	Elevators	
CD-stereo system	Free newspaper	
Shower only	Game room	
Trouser press	Gift/sundry shop	
In-room pay movies	Handicapped room	
Shared bath	Horseback riding	
Coffee/tea making facilities	Interior decors	
Individual climate control	Laundry/valet	
Work desk	Limited medical services	
1 bed and 1 sofa	Massage treatments	
Wheelchair accessible	Multilingual staff	
Balcony	Non-smoking rooms	
Hydro massage bathtubs	Parking	
Living room	Parking (fee)	
Crib on request-fee may apply	Piano bar/lounge	
Sound proof room/windows	Playground/play area	
	Pool bar	
	Restaurant(s)	
	Room service	
	Safe deposit box	
	Shuttle to airport	
	Swimming pool	
	Tour desk	
	Wedding services	
	Wireless high speed Internet	

Source: Kisilevich et al. (2013, p.1123)

By virtue of the fact that hotel characteristics are sources of differentiation, the effect of the relevant characteristics on prices can be extended to price dispersion. As the literature on hedonic pricing suggests, differentiation gives hotels the ability to set prices rather simply adjust to a market price (Becerra et al., 2013). Based on this, it can be argued that product and hotel characteristics may influence the pricing behaviour of hotels. To the extent that a hotel's characteristics differentiate it from its competitors, it can be argued that differentiated hotel's prices will be less subjected to competition and therefore relatively more stable (i.e. less frequency of price change and dispersion).

2.12 Empirical studies on online pricing behaviour

Following the advent of the Internet and the subsequent emergence of the online market, an increasing number of empirical studies have been conducted on online pricing behaviour (Alam et al., 2001; Alderighi, 2010; Barron, Taylor & Umbeck, 2004; Baye et al., 2004; Borenstein & Rose, 1994; Gerardi & Shapiro, 2009; Lewis, 2008; Mantin & Koo, 2009; Puller & Taylor, 2012). So far, the studies have focused mainly on price dispersion, with other aspects of online pricing behaviour such as frequency of price change and pattern of price change receiving limited attention. Industries that have gained the attention of researchers include gasoline (Barron et al., 2004; Lewis, 2008), prescription drugs (Sorensen, 2000), consumer electronic products (Baye et al., 2004), automobile insurance (Dahlby & West, 1986), and airlines (Alam et al., 2001; Alderighi, 2010; Borenstein & Rose, 1994; Gerardi & Shapiro, 2009; Mantin & Koo, 2009; Puller & Taylor, 2012).

Among the numerous industries that have attracted research efforts, the airline industry appears to dominate the literature, with most of the studies again conducted on US airlines. Gerardi and Shapiro (2009) attribute this to the fact that, after the 1978 deregulation of the American airline industry, a great of deal of data became publicly available and accessible to researchers and, at the same time, price discrimination became widespread and evident. Given that the airline industry shares some similarities with the hotel industry in terms of pricing and revenue management practices, a review of the studies in the airline is considered to be relevant and therefore is given the necessary attention in the next section.

2.12.1 Price dispersion studies in the airline industry

As indicated in section 2.12 already, there is an extensive empirical literature on price dispersion in the airline industry and a review of selected studies can only be provided in this section. In the selection of the studies, preference is given to those studies that are relevant to the hospitality industry. Special attention is also given to the studies that contribute to the identification and operationalization of the factors that can influence online price dispersion in the hotel industry.

Starting from the late 1980s, Borenstein (1989) investigated the relationship between the market share of airlines and the prices they charge. Results from this study indicated that the relative price between a carrier and its competitors was determined by the flight route and airport dominance. Carriers with higher market share on a route and endpoint airport dominance were charging higher prices on the average than their competitors on the same route.

Analysing a random sample of 10% of U.S. domestic airline tickets, Borenstein and Rose (1994) found that considerable price dispersion exists in the fares charged to different passengers on the same route. Specifically, the authors found that, for any two randomly chosen passengers on the same airline and route, the average expected price difference could be as much as 36%. The differences in the fares were observed to be related to ticket characteristics such as refundability, advance purchase discounts, Saturday night stays, and various travel and stay restrictions.

Also, consistent with the models of monopolistic competition presented by Borenstein (1985) and Holmes (1989), the authors found that competitive routes exhibited more price dispersion than the less competitive routes but increased market density and high concentration of tourist traffic lowered price dispersion. Furthermore, the results of their study showed that airlines that operated a computer reservation system (CRS) generally had a relatively higher price dispersion than carriers that did not operate a CSR.

In a similar study, Gerardi and Shapiro (2009) found a contrasting effect of competition on price dispersion. That is, the researchers found that an increase in competition over time resulted in a reduction in price dispersion. Further, Gerardi and Shapiro (2009) noted in their study that; the effect of competition was stronger on routes with heterogeneous mixture of business travellers and leisure travellers. Again, contrary to Borenstein and Rose's (1994) explanation of brand theory of pricing, competition was found to lower price dispersion at the top of the price distribution to a greater extent than it lowers prices at the bottom of the price distribution. Reconciling their findings with that of Borenstein and Rose (1994), Gerardi and Shapiro (2009) points out that the differences could be related to the estimation techniques adopted. That is, as opposed to the cross-sectional estimates presented by Borenstein and Rose (1994), which can be said to suffer from omitted variable bias, Gerardi and Shapiro (2009) adopted a panel estimation technique to control for route-carrier characteristics.

In a study by Obermeyer et al. (2012), the effects of competition on price dispersion was investigated in European airline markets by conducting cross sectional analysis of over 1200 flights. The findings confirmed an inverse U-shaped relationship between competition and price dispersion for economy-class flights, indicating that competition either induces an increase or decrease in price dispersion depending on the actual level of the market competition. Additionally, the study found that the presence of low-cost carrier (LCC) had similar effect observed by Mantin and Koo (2009). That is, overall price dispersion was higher on routes where LCCs are present. While the findings of Obermeyer et al. (2013) confirmed some of the relationships in previous studies (Gaggero & Piga, 2011; Mantin & Koo, 2009), it contradicted the observation of Mantin and Koo (2009) on the effects of population and passenger on price dispersion. The study also found contradictory results to Borenstein and Rose’s (1994) study, which demonstrated that price dispersion was higher on tourist routes.

Mantin and Koo (2009) analysed the factors that influence variations in daily airfares over a fare history and found that dynamic price dispersion was significantly influenced by demand characteristics such as population, income and shares of business passengers as well as the competitive pressures from low-cost carriers, suggesting that in the presence of low-cost carriers, full-service careers tend to adopt a more aggressive high-low price strategies. However, the intensity of competition was not found to influence price dispersion. As expected, the impacts of the variables were found to be different at different times in the fare history. Basically, the variables tended to have relatively higher impacts closer to the departure date.

2.12.2 Price dispersion studies in the hotel industry

In view of the many similarities between the hotel industry and the airline, one would have expected that an equivalently high number of studies would have been conducted on the hotel industry just as in the airline industry. especially so, when the studies on price dispersion have been argued to be very important for capacity-constrained firms which are able to practice price discrimination through effective market segmentation (Chellappa, Sin & Siddarth, 2011). But, surprisingly, only few studies have been conducted in the hotel industry (Abrate et al., 2012; Balaguer & Pernías, 2013; Becerra et al., 2013). These studies are extensively reviewed in the subsequent paragraphs.

In Balaguer and Pernías's (2013) study, the authors examined daily room rates of 219 hotels collected online for a week to determine relationships between spatial agglomeration of sellers and average price, on the one hand, and spatial agglomeration and price dispersion, on the other hand. In line with the predictions of monopolistic competition models, the findings revealed that greater density of sellers has a negative impact on average price and price dispersion, with the effects becoming stronger on a weekday than a weekend. Furthermore, average price on weekday was found to be more sensitive to competitors with the same official star rating than those with different star rating. In other words, in spatial locations where there were a number of hotels with similar official star rating, the average price for a weekday was lower than in similar locations where the star rating of the hotels were different. But, in the case of average price on weekend, competitors of all categories were found to have the same effects on the average price, suggesting that the degree of substitution among different classes of hotels was higher on weekends (i.e. for tourism consumers) than on weekdays (i.e. for business people).

Using a similar strategy for data collection online, Abrate et al. (2012) showed that hotels in European markets practised dynamic or inter-temporal pricing. Their study found that the nature of dynamic pricing structure in the various cities was not the same but depended on factors such as type of customer (either a booking was made on a weekday or a weekend), the star rating of the hotel and the number of suppliers with available rooms. For a weekday booking, the study found that the price of a single room advertised on the Internet declined as the check-in date approaches, but for a weekend booking, the reverse trend was found: as the check-in date got closer, price tended to increase. However, irrespective of whether booking was done for a weekday or weekend, the study found that last minute-bookings were characterized by higher price differential than early bookings and the difference was even more pronounced in high star hotels than low star hotels when the booking was for a weekend.

Also, in another study by Becerra et al. (2013), the authors examined the effects of differentiation and competition on pricing policy of hotels in Spain. The study found that competition has a negative effect on average price while differentiation, vertical and horizontal, has a positive effect on room price but negative effect on room discounts which was taken to be a measure of price dispersion. The effect of vertical differentiation (being better) was found to be higher than the effect of horizontal differentiation (being different). Interacting the competition variable with differentiation variables, the authors found that; as competition inreases, being better in a competitive environment was more effective at insulating a hotel from the competitive pressure to reduce price or offer higher discounts than being different. Table 2.7 summarizes the relevant studies on price dispersion both in the airline and hotel industries.

Table 2. 7: Summary of selected research on price dispersion

Author(s)	Industry/ market	Subject of Analysis	Measure(s) of price dispersion	Independent variables	Summary of Major finding
Borenstein and Rose (1994)	US Airline	Transaction price of airline tickets (quarterly data)	Gini coefficient	Market structure variables (HHI of concentration, monopoly route, duopoly route and competitive), population characteristics (tourist/business mix, market density, market share) and product attributes (endpoint dominance), peak-load	Airline prices show considerable dispersion. Competitive routes exhibit more price dispersion while increased market density and high concentration of tourist traffic reduce price dispersion. Furthermore, the findings suggest that price discrimination is an important source of price dispersion.
Hayes and Ross (1998)	US Airline	Transaction price of airline tickets (quarterly data)	Gini coefficient, Atkinson index and Entropy index	Market power (hubness), market share, number of carriers, HHI of concentration), number of scheduled non-stop flights, average price for a carrier/route per mile, percentage of passengers flying roundtrip, load factor, plane size, distance, percentage of stopovers, dummies for carriers with financial difficulty	Price dispersion is related to peak load pricing and fare wars from carriers with financial difficulty. Competition from some carriers reduce price dispersion
Clemons et al. (2002)		Prices for airline tickets sold online			Price dispersion higher online

Giaume and Guillou (2004)	European airline market	Price for airline tickets (single day)	Coefficient of variation	**independent variables are not for price dispersion**	Concentration and price discrimination are negatively related
Alegre and Sard (2009)	British and German Tour operating market	Package holiday prices including accommodation (high season for two years)	Residuals of hedonic-based regressions	**independent variables are not for price dispersion**	Persistent price differences exist among tour operators. The observed price differences are in terms of inter-operator, intra-operator and inter-temporal. The distributions of price dispersion are not static indicating that the market responds swiftly to demand conditions
Mantin and Koo (2009)	US Airline	Airfares (daily data)	Power divergence statistic	Distance between airports on the route, average population of origin and destination, average per capita income of the origin and destination, average number of passengers on board, HHI of concentration, total number of scheduled non-stop flights, market share of low-cost carriers, business index, average lowest airfare on a route	Dynamic price dispersion is influenced by population, income, share of business passengers and competitive pressures of low-cost carriers but not the intensity of competition. As the departure date approaches, the impact of the factors increases.
Gerardi and Shapiro (2009)	US Airline	Transaction price of airline tickets (quarterly data)	Gini coefficient,	Competition (HHI concentration, number of carriers, number of low-cost carriers, number of legacy carriers), market share,	Competition has a negative effect on price dispersion and the magnitude of the effect vary according to route

			price percentiles	number of departures, hubness, ratio of accommodation earning to total nonfarm earnings, average seat capacity, distance, mean population of end-point cities, total enplaned passengers,	characteristics. On routes with heterogeneous customer base, the effect of competition is more pronounced than routes with homogeneous customers.
Gaggero and Piga (2011)	UK airline market connecting to Ireland	Airfares posted on the Internet (specific days before departure)	Gini coefficient	Competition (route HHI, city-pair HHI, total number of flights), flight characteristics (frequency of flights, load factor, departure time) Season (month, Christmas, Easter), demand heterogeneity (HHI for travel purpose)	Competition and price dispersion are negatively related and weaker in peak periods, suggesting that competition is likely to hinder airlines' ability to price discriminate
Obermeyer et al. (2013)	European Airline market	Online ticket prices (selected daily data)	Gini coefficient, Theil index, Atkinson index	HHI of concentration, number of flights available on a route, presence of low-cost carriers, tourist destination, distance between origin and destination, average population between two endpoints, mean number of passengers, departure time	The relationship between competition and price dispersion in the European airline market is non-monotonic and the precise relationship between competition and price dispersion is U-shaped. Depending on the actual level of market concentration, an increase in competition may decrease or increase price dispersion
Abrate et al. (2012)	European hotel	Online room rates (selected daily data)	Coefficient of variation	**independent variables are not for price dispersion**	Hotels in European cities of Amsterdam, Berlin, Madrid, Paris, Prague, London, Rome and Vienna practise dynamic

					pricing and the inter-temporal pricing structure depends on type of customer, star rating and the number of hotels with available room
Dai, Liu and Serfes (2014)	US airline market	Transaction price of airline tickets (quarterly data)	Gini coefficient	HHI of concentration, market structure (monopoly, duopoly and competitive), total asset, cash available, operating expenses, non-operating income, bankruptcy indicator, mean population of endpoints, enplanements at endpoints	An inverse-U relationship (non-monotonic) is found between competition and price dispersion, where an increase in competition is associated with greater price dispersion in concentrated market but associated with less price dispersion in competitive markets
Balaguer and Pernías (2013)	Spain hotel market		Variance of residuals from hedonic regressions	**independent variables are not for price dispersion**	Spatial agglomeration of hotels affects average price and price dispersion. A large number hotels (greater density) result in lower average retail price and less price variance.

2.13 Criticisms of previous research and gaps identified for the current study

From the literature review that has been presented, it is evident that the bulk of studies on online pricing behaviour have been conducted on the airline industry and in particular the US airline industry. This in itself is not considered to be adverse, as those studies have made significant contributions to deepen the understanding on online pricing behaviour. However, to the extent that the hotel industry has its own unique characteristics, the transferability of the findings from the airline industry to the hotel industry can greatly be impeded. For example, while the market for an airline can clearly be defined as its routes, this definition cannot be applied to identify the market characteristics that influence online pricing behaviour in the hotel industry. To this end, hotel-industry-specific studies would be more desirable at addressing the gaps in the hotel industry.

A common limitation identified with the studies of Abrate et al. (2012) and Balaguer and Pernías (2013) on online pricing behaviour in the hotel industry is that, in view of the short period over which data were collected, the authors could not analyse the difference in pricing behaviour over different demand seasons even though it is a fact that the hotel industry goes through high and low seasons of demand (Pearce & Grimmeau, 1985; White & Mulligan, 2002). More significantly, a major limitation with the study by Balaguer and Pernías (2013) is that within the spatial agglomeration of sellers, there was no distinction of hotels in terms of rate categories and thus, concealing some information on how the presence of neighbouring hotels affects room rates and price dispersion. For example, their findings do not shed light on the possible effects of lowly-priced hotels on the pricing behaviour of highly-priced hotels and vice versa. Thus, a further investigation into this subject will therefore allow a contribution to be made to the extant literature.

Aside the lack of depth pointed out in the prior studies, other important aspects of online pricing behaviour have escaped the attention of hospitality researchers. Critical among these are the frequency and pattern of price change. The absence of studies on these pricing behaviours has limited the understanding on online pricing behaviour in many important ways. For example, although it is believed that price can easily be varied on the Internet due to the low cost of adjusting prices on the Internet, it is not clear how often hotels in different segments and location are able to vary their rate, neither is it known whether price variations on the Internet exhibit some systematic patterns within a given market. In the market for durable goods for example, Pratt et al. (1979) found that prices of more expensive products tend to exhibit the greatest variation across stores, but it still remains unknown if similar conclusions can be drawn for the room rates of high-end hotels.

In view of the criticism raised above, it is undeniable that there are still a number of knowledge gaps in the hospitality literature, as far as online pricing behaviour is concerned, that needs to be addressed. To this end, the following specific research gaps have been identified for investigation in this study. First, even though it is widely recognized that the Internet enables hoteliers to frequently adjust room rates due to the implementation of revenue management software and the relatively low cost of changing prices on the Internet, till date, there is no empirical study in the hospitality literature that has systematically investigated the frequency of price change over a given period and to identify the factors influencing the frequency.

Second, the lack of a study to identify the factors that influence the frequency of price change limits the knowledge of strategic consumers and competitors who may wish to predict, at least, the direction of future changes in room rates based on the observable characteristics of hotels and their location in the market. This knowledge gap makes it difficult to determine if hotels maintain any "price-image" (stable or unstable price changes) at all on the Internet or they exploit the Internet to change their prices in a randomized fashion that may prevent consumers from identifying low-price hotels.

Lastly, the literature on online pricing suggests that room rates are adjusted dynamically over time due to the implementation of revenue management (Abrate et al., 2012; Bitran & Caldentey, 2003). However, little is known about the magnitude of dynamic price dispersion over a given period. Related to this research gap, there are also no empirical studies accounting for the magnitude of dynamic price dispersion in terms of locational attributes, hotel characteristics and structure of the markets within which hotels operate. Particularly, the effects of localized competition and spatial heterogeneities on dynamic price dispersion have not been investigated even though economic theories (i.e. the structure-conduct-performance and spatial agglomeration) suggest there could be causal linkages. To address these research gaps, a conceptual framework incorporating the prior literature is proposed in the next section.

2.14 Conceptual framework

After the extensive review of the literature, a conceptual framework is constructed to address the research gaps identified for this study. Schematically, Figure 2.3 presents this conceptual framework which stipulates that online pricing behaviour, consisting of frequency of price change, pattern of price change and magnitude of dynamic price dispersion, is influenced by three set of factors, namely hotel characteristics, location attributes of hotels and market structure characteristics.

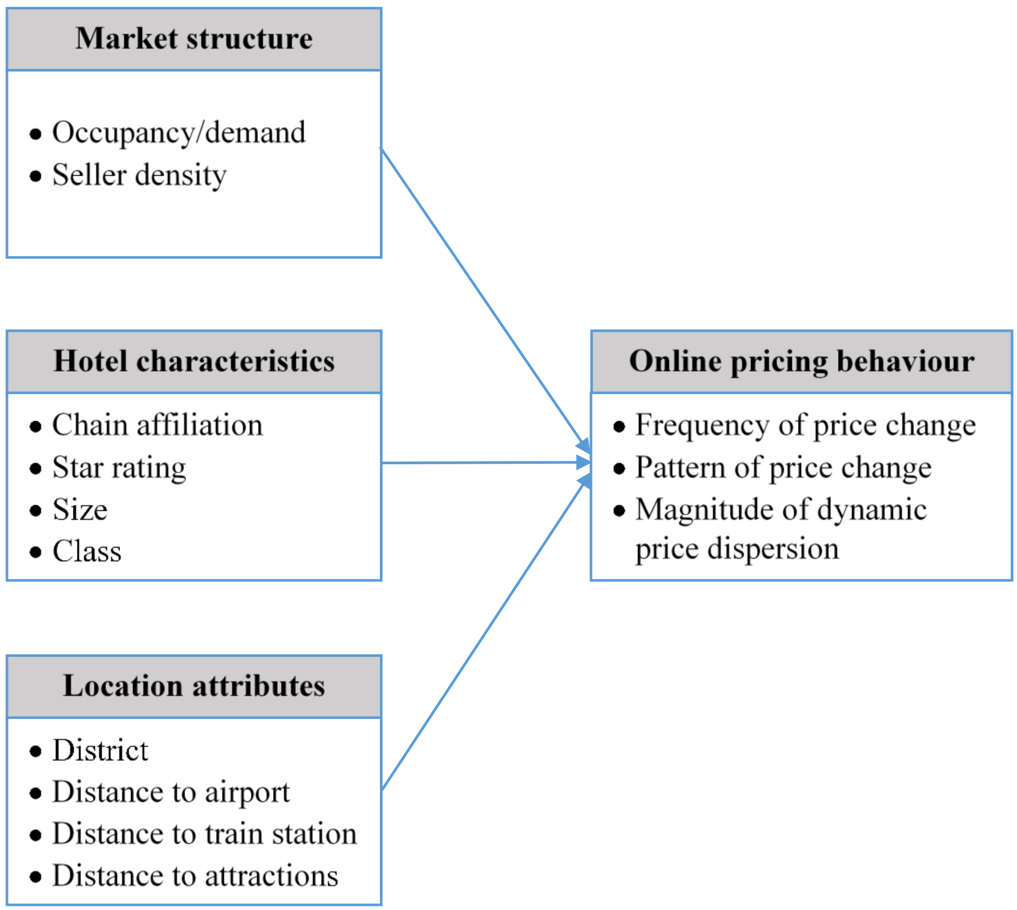


Figure 2. 3: Conceptual framework

The proposition of the conceptual framework is fundamentally based on the first two elements of industrial organisation economics literature on structure conduct performance (SCP) theory and the allied literature on pricing determinants in hospitality studies, especially the hedonic pricing theory. The literature on market structure contributes to identifying market structure characteristics as one of the main factors influencing online pricing behaviour while the literature on pricing determinants is used to identify the location attributes and hotel characteristics that may influence online pricing behaviour.

To shed more light on the conceptual framework, Table 2.8 provides a description of the concepts in the framework and their measurements. In addition, the relevant studies that have previously used the concepts and their measurement are provided.

Table 2. 8: Concepts operationalization and empirical referents

Key Terms	Concepts	Measurements	References
Online pricing behaviour	Frequency of price change	Count of room rate change	Cecchetti (1986); Powers and Powers (2001)
	Pattern of price change	Average direction of room rate change	Chen and Schwartz (2008)
	Dynamic price dispersion	Coefficient of variation	Abrate et al. (2012)
Market structure characteristics	Demand and spatial competition	Occupancy, Number of sellers	Balaguer and Pernías, (2013)
Hotel characteristics	Size, quality, management	Number of rooms, star rating, chain affiliation, class	Abrate et al. (2011); Schamel, (2012); Zhang et al., (2011); Hung et al., (2010); Bull, (1994); Canina et al. (2005)
Location characteristics	Location attractiveness and accessibility	Distance to tourist attractions, distance to airport, distance to nearest train station, district of location	Balaguer and Pernías (2013); Lee and Jang (2011)

2.14.1 Rationale behind the proposed conceptual framework

Before proceeding to examine the causal effects of the predictors (i.e. the left-hand side variables in the framework) on online pricing behaviour, it is worthwhile to consider briefly the rationale or justification for the conceptual framework. As indicated previously in sections 2.9.1 and 2.14, the cornerstone of this framework is the SCP theory, which stipulates that there is a causal relationship between the structure of a market and the conduct of the firms in that market. By adopting this paradigm, online pricing behaviour is considered to be a form of firm behaviour and therefore, to identify the factors influencing such behaviour, the SCP framework comes in handy as a starting point. Thus, based on the SCP theory, it is hypothesized that online pricing behaviour is influenced by the market structure of hotels.

The other two sets of variables, namely location attributes and hotel characteristics, are incorporated into the theory, given the special nature of hotel products, which makes these characteristics inherently part of the product. In fact, the hedonic pricing theory lays the foundation for the prices of hotel rooms to be seen as composites which involve all the utility-bearing attributes of hotel products. The causal relationships between online pricing behaviour and the explanatory factors are provided in section 2.14.2. As depicted in Figure 2.2 and Table 2.8, the dependent variables are first of all assumed to be influenced by the same set of explanatory variables because the three dependent variables are just but different aspects of firms' conduct, all of which are conceptualized as online pricing behaviour. Besides, the empirical literature drawn from other industries such as the airline offers some support to this reasoning (Borenstein & Rose, 1994; Hayes & Ross, 1998; Mantin & Koo, 2009).

2.14.2 Hypotheses in the conceptual framework

To begin with, there are three aspects of online pricing behaviour that are hypothesized to be influenced by three categories of predictors. These online pricing behaviours are frequency of price change, pattern of price and magnitude of dynamic price dispersion. For each of these pricing behaviours, a set of characteristics under the broad headings of market structure, hotel and location are deemed to be the influencing factors.

2.14.2.1 Market structure and online pricing behaviour

The airline industry literature supports the market structure-pricing relationship and the relevant market structure characteristics identified from previous research includes number of slots available at the airport (an indicator of capacity constraint), number of airlines competing on a route, distance and market concentration (Borenstein; 1989; Borenstein & Rose, 1994; Chellappa et al., 2011). However, unlike the airline industry, where a market refers to the route or origin-destination pair of airports, the hotel industry has no such clear definition of a market. In the absence of such a clear definition of market, some hospitality researchers (Balaguer & Pernías, 2013; Baum & Mezias, 1992) have defined the market for any given hotel to be a certain x-distance around that hotel. For example, the market for hotel A will be defined as x-distance around the location of hotel A.

Although this approach could be sensitive to the measure of x-distance, it does reflect adequately the priority consumers give to location when choosing a hotel. In addition, it also makes it possible to view competition at a localized level than at a macro level. In this study, a similar approach is adopted and the relevant market characteristics that are included as measures of market structure are demand and the number of hotels within the localized market. Following the example of Abrate et al. (2012) study, the hypotheses between the market structure variables and the three dependent variables are stated as follows:

Hypothesis 1a: The frequency of price change in the Hong Kong hotel market depends on market structure factors such as demand/occupancy and seller density.

Hypothesis 1b: The pattern of price change in the Hong Kong hotel market depends on market structure factors such as demand/occupancy and seller density.

Hypothesis 1c: The magnitude of dynamic price dispersion in the Hong Kong hotel market depends on market structure factors such as demand/occupancy and seller density.

Noticeably, the hypotheses are not stated in any particular direction due to the lack of agreement in the theoretical literature. For example, in the case of the effect of market structure on price dispersion, the implied relationship between the number of competing firms and the level of price dispersion differs between search models and spatial competition models. Barron et al. (2004) highlight these conflicting results by noting that an increase in the density of stations in a spatial model implies less price dispersion, while search models of Varian (1980) and Carlson and McAfee (1983) find that price dispersion rises with the number of firms. The other important reason for stating the hypotheses as such is due to the specific objective of this study which is: to identify the factor that influence the frequency, direction and magnitude of dynamic price dispersion. For this kind of objective, it is necessary to test the hypotheses under two tailed assumptions. These are consistent with prior studies (Abrate et al., 2012).

2.14.2.2 Hotel characteristics and online pricing behaviour

The relative market powers of firms in any market are often attributed to their differences in terms of characteristics and products. In the market for physical goods for example, brand image can empower a seller to charge consumers different prices for the same product or the concern for impressing a certain “price image” in the minds of consumer can cause a firm to maintain less price fluctuations (Bynjolfsson & Smith, 2000). In the airline industry, the hub-and-spoke system is considered to be one of central characteristic of an airline because an airline can exercise a greater market power over other flights that originate/end at its hub (Borenstein, 1989; Gerardi & Shapiro, 2009).

Within the hotel industry, both reputation-based attributes (non-physical characteristics) and facilities and amenities (physical characteristics) are the factors that when considered together or individually differentiate one hotel from the other. Coenders, Espinet and Saez (2003) emphasize the importance of different hotel characteristics to business and leisure travellers. Differentiation in the hotel industry has been shown to be an important strategy that influences pricing. Becerra et al. (2013) for example, have shown that being different (horizontal differentiation) or better (vertical differentiation) contributes to pricing policy in general and protects hotels from the pressure to reduce prices as competition increases. On the core of this finding, it can be further argued that to the extent that a hotel’s characteristics differentiate it from its competitors, those characteristics can influence the pricing behaviour of that hotel. Therefore, the following hypotheses are specified:

Hypothesis 2a: The frequency of price change in the Hong Kong hotel market depends on hotel characteristics such as chain affiliation, star rating, size and class of hotel.

Hypothesis 2b: The pattern of price change in the Hong Kong hotel market depends on hotel characteristics such as chain affiliation, star rating, size and class of hotel.

Hypothesis 2c: The magnitude of dynamic price dispersion in the Hong Kong hotel market depends on hotel characteristics such as chain affiliation, star rating, size and class of hotel.

2.14.2.3 Location characteristics and online pricing behaviour

When it comes to hotel rooms, it is well known that location forms part of the product. This is because unlike other service industries such as legal counselling, whereby the service provider does not have to be physically present where the production of the service is taking place, hotel services are characterized by inseparability of production and consumption (Helmers, 2010). In view of this, several authors have demonstrated the importance of location in hotel business. Particularly, the predictive ability of location attractiveness and uniqueness in explaining lodging prices has been established by Andersson (2010), Becerra et al. (2013), Carvell and Herrin (1990), Chen and Rothschild (2010), Lee and Jang (2011), Monty and Skidmore (2003), Papatheodorou (2002), and Thrane (2005). Shoval (2006) as well as Egan and Nield (2000) have also demonstrated that the location of a hotel may determine its clientele and the premium price it can charge for its products.

In consideration of these arguments, it is posited that online pricing behaviour of hotels in different locations can be influence by the attributes of the location within which they operate. For hotels that are found in attractive and convenient locations, they may be able to charge premium price for their services (Baylis & Perloff, 2002; McMillan & Morgan, 1988; Sutton, 1980) which could affect price dispersion. Also, in consideration of the fact that hotels tend to cluster around geographically attractive places, price fluctuation may tend to be more frequent as result of the spatial agglomeration (Balaguer & Pernías, 2013). In view of the importance of location characteristics in hotel business, the following hypotheses are proposed:

Hypothesis 3a: The frequency of price change in the Hong Kong hotel market depends on location attributes such locational district, distance to airport, distance to the nearest train station, and distance to top attractions.

Hypothesis 3b: The pattern of price change in the Hong Kong hotel market depends on location attributes such locational district, distance to airport, distance to the nearest train station, and distance to top attractions.

Hypothesis 3c: The magnitude of dynamic price dispersion in the Hong Kong hotel market depends on location attributes such locational district, distance to airport, distance to the nearest train station, and distance to top attractions.

2.15 Summary of the chapter

This chapter presented a review of the literature on online pricing to provide a deeper understanding of online pricing behaviour and propose a conceptual framework for this study. The review covered substantial theories relating to pricing in the hotel industry, revenue management and dynamic pricing as well as the theories underlying online pricing behaviours regarding frequency of price change, pattern of price change and magnitude of dynamic price dispersion. Important among the theories reviewed on price dispersion were the search-theoretic models, which appear to be less effective in explaining pricing dispersion on the Internet market compared to information clearinghouse models. The next chapter presents the methodology adopted to address the objectives of the study.

CHAPTER 3: METHODOLOGY

3.0 Introduction

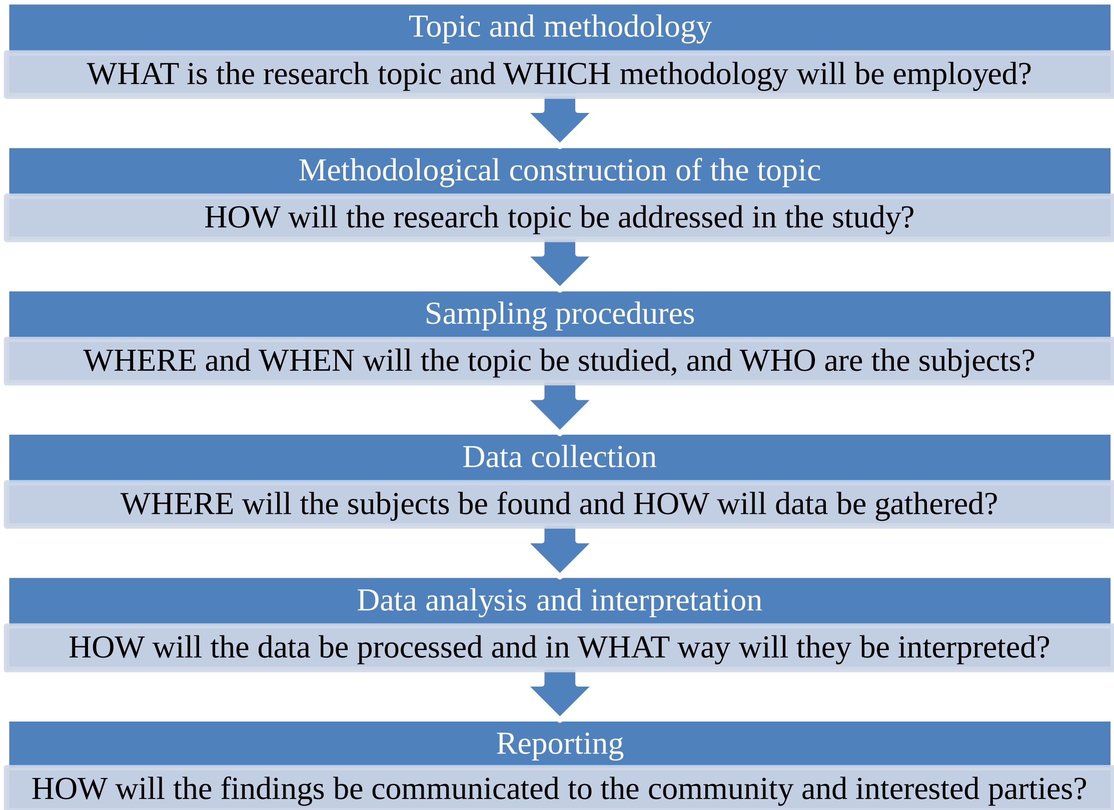
Following the literature review and conceptual framework developed in the previous chapter, this chapter presents the methodology of the study, which explains the techniques and strategies that were adopted to achieve the objectives of the study. As a starting point, the objectives of the study required a mix of descriptive and causal research design following the positivist research paradigm. The descriptive design was used to demonstrate the properties of the data which informed the selection of the appropriate regression methods for the causal design. Appropriate to each objective of the study and the properties of the data, three sets of econometric panel data models were used.

The first set of panel data models involved the Poisson and Negative Binomial count data models. These models were used to analyse the factors influencing the frequency of room rate change. The second set involved Logit and Probit models. The goal of these models was to determine the factors that make a hotel more or less likely to increase its room rate. The final group of panel data models was spatial models, including the Spatial Autoregressive, Spatial Error model and Spatial Durbin model. These models were used to examine the interaction effects between the size of a hotel's room rate change and the effects from neighbouring hotels. After estimating these models, diagnostic checks were also conducted to assure that the data satisfied the assumptions of the various models. Lastly, a summary is provided to conclude the chapter.

3.1 Research design

At the heart of every research methodology is a research design, the purpose of which is to guide and focus the research on achieving its objectives (Hussey & Hussey, 1997). According to Zikmund (1991), research design can be viewed as the master plan of the research methodology which specifies the exact methods and procedures for conducting a particular research. Given that different research may have different objectives, researchers (Cooper & Schindler, 2003; Saunders, Lewis & Thornhill, 2009; Simon, 1969; Zikmund, 2000) argue that there cannot be a single design that addresses all research problems. Hence, the choice of any particular research design should be largely guided by the objectives of the study and the researcher's philosophy (Zikmund, 2000).

In previous literature, several attempts have been made to provide guidelines on how to formulate a research design. One such example which is considered to be elaborate and followed in this study is the work of Sarantakos (2005). According to Sarantakos (2005), a well-planned research design should align the topic with the methodology and provide explanations on the sampling procedures, data collection, analysis and interpretation, and reporting. Based on this reasoning, Sarantakos (2005) proposed five steps that can be followed to formulate a research design. These steps are illustrated in Figure 3.1. In each step, the critical question(s) to be addressed are also provided.



Source: Adapted from Sarantakos (2005, p.105)

Figure 3. 1: Steps for developing a research design

Reflecting on the first two questions in the above guidelines and the objectives of this study, a quantitative research design involving descriptive and causal analyses was deemed appropriate for the topic of this study. The descriptive analyses, involving means, standard deviations and percentages, were used to characterize online pricing behaviour while the causal analyses involving panel regression techniques were used to establish causal relationships amongst the variables of interests. The choice of these methods and strategies were also in conformity with the strategies adopted by similar studies in the hotel and airline industries (Abrate et al., 2012; Balaguer & Pernías, 2013; Baye et al., 2004; Borenstein & Rose, 1994; Chellappa, et al., 2011; Gaggero & Pigga, 2011; Gerardi & Shapiro, 2009; Mantin & Koo, 2009).

In order to explain how the other issues identified in Figure 3.1 are addressed in this study, the remainder of the methodology is organized around the following thematic subjects:

1. Population and sampling
2. Data collection
    a. Data requirements and sources
    b. Data scraping software
    c. Pilot testing of the software
    d. Main data collection
3. Data management and preparation
    a. Cleaning and processing the data
    b. Constructing a balanced panel data for analysis
    c. Exploring the data to identify empirical regularities and variations in prices
4. Econometric specifications and estimation
    a. Model specification
    b. Empirical estimation techniques
5. Diagnostic tests to check model adequacy and fit
6. Examination of the findings in relations to theory and hypotheses
7. Drawing up of relevant conclusions to support the conceptual framework

3.2 Population and sampling

Cooper and Schindler (2003) define a research population as the set of elements about which a researcher wishes to make inferences. For this study, the population was broadly defined to include all establishments in Hong Kong that are officially registered as hotels by the Hong Kong Tourism Board (HKTB). Similar to other studies conducted in Hong Kong (Tsai & Gu, 2012; Li, Fang, Huang & Goh, 2015), this definition was adopted because the HKTB is the official institution that collates and publishes information on hotels in Hong Kong. As at the end of April 2014 (the month before the commencement of the data collection), there were 229 hotels registered with the Board (HKTB, 2014), hence this number effectively constituted the population of this study.

Out of the registered number of hotels, the target population and sample were defined based on two conditions. First, because the study was interested in analysing online pricing behaviour of hotels, it was logical to target only hotels with advertised room rates on third party channels. Second, the hotels had to have sufficient data for meaningful analysis. In respect of the second condition, the targeted hotels needed to have room availability at least at the beginning of each data collection period. In the end, the number of hotels satisfying these two conditions yielded a consistent sample of 126. For the sampled hotels, the unit of analysis was the best available rate (BAR) for a single night stay in a standard twin/double room. The standard twin/double room was chosen for this study because it was the commonest room type in the Hong Kong hotel industry and therefore could constitute a good basis for comparison.

3.3 Data collection

3.3.1 Data requirements and sources

Appropriate to the data requirements of this study (see Table 3.1 for a list of the data frame), comprehensive data were gathered from different sources including an Internet distribution channel (i.e. Kayak.com), Smith Travel Research (STR), the Hong Kong Tourism Board's (HKTB) publications, and Google map. Specifically, all the price data were crawled from kayak.com. The decision to use kayak.com for the data collection was informed by the results of a survey by HawkPartners (2012), which indicated that kayak.com was the only online price comparison website among the top ten online resources customers widely use to search for hotel information. However, the overreaching reason for choosing a price comparison website as opposed to any single Online Travel Agency (OTA) was to first ensure that the minimum best available rates were obtained. Secondly, it was to avoid any bias as pointed out by Schamel (2012) that could be introduced by using one particular OTA. Lastly, the preference for a comparison website was to minimize survivorship bias that may be caused by some OTAs selling out rooms and to obtain as large sample as possible.

Table 3.1 provides a description of the data that were required for this study and the corresponding sources from which these data were gathered. In addition to the sources of the data, the table also provides information on some attributes of the data that are relevant to choosing the models for the empirical analyses (i.e. whether they are continuous or discrete, time-variant or time-invariant). For some data such as number of rooms, it can be observed from the table that multiple sources were relied upon. These were the cases where data from one source was incomplete.

Table 3. 1: Sources of data

Data	***Online?***	***Source***	***Type of data***	***Nature of data***
Best available rate	Yes	Kayak.com	Continuous	Time-variant
Coordinates of hotels	Yes	Kayak.com	Continuous	Time-invariant
Facilities and amenities	Yes	Kayak.com	Nominal	Time invariant within the data collection period
Star rating*	Yes	Kayak.com	Ordinal	Time-invariant within the data collection period
Online ratings	Yes	Kayak.com	Ordinal	Time-variant
Number of reviewers	Yes	Kayak.com	Discrete	Time-variant
Age (years)	No	HKTB/STR	Discrete	Time-invariant within the data collection period
Number of rooms	No	HKTB/STR/ hotel website	Discrete	Time-invariant within the data collection period
Hotel district	No	HKTB	Nominal	Time-invariant
District-level occupancy	No	HKTB	Ratio	Time-variant
Affiliation	No	STR	Nominal	Time-invariant within the data collection period
Class	No	STR	Ordinal	Time-invariant within the data collection period
Aggregated rooms sold (Demand)	No	STR	Discrete	Time-variant
Aggregated Occupancy	No	STR	Ratio	Time variant

Coordinates of tourist attractions	Yes	Google maps	Continuous	Time-invariant
Coordinates of the international airport	Yes	Google maps	Continuous	Time-invariant
Coordinates of the train stations (MTR)	Yes	Google maps	Continuous	Time-invariant

Notes: the coordinates were measured in degrees, HKTB = Hong Kong Tourism Board, STR = Smith Travel Research. The top ten tourist attractions (according to HKTB) are the Avenue of Stars, the Peak, Ocean Park Hong Kong, Hong Kong Disney, Ladies' Market, Temple Street Night Market, Hong Kong Convention and Exhibition Centre (and Golden Bauhinia Square), Tsim Sha Tsui Promenade, Sik Sik Yuen Wong Tai Sin Temple; and the Clock Tower

* The star rating from kayak.com was used because Hong Kong does not have a formal star rating system. The existing classification system which rates hotels as High Tariff A, High Tariff B and Medium Tariff is not publicly available.

3.3.2 Data scraping software

In dealing with large sample and frequently-changing online data such as hotel room rates and air fares, it is almost practically impossible to capture the data manually. Even where it is possible, the numerous advantages of using automated systems have made it more attractive to use an automated system than to use manual techniques. Among the several advantages of using automated systems for data collection, it has been reported that web-scraping techniques reduces human errors associated with data collection and provides an up-to-date information in the most efficient way (Allen & Wu, 2002; Kauffman & Wood, 2003). In view of these benefits, a growing number of researchers have relied on this approach, as far as practicable, to collect data for pricing studies (Baye et al., 2004; Brynjolfsson & Smith, 2000; Clay et al. 2002; Clemons et al., 2002; Escobari & Gan, 2007; Kauffman & Wood, 2007; Lee, 1998; McAfee & Te Velde, 2006).

Following the examples of Abrate et al. (2012), Balaguer and Pernías (2013), Becerra et al. (2013) and Schamel (2012) that have similarly applied web-scraping technology to study pricing in the hotel industry, this study also designed a data-gathering bot that could enable the automatic data crawling from kayak's website (i.e. www.kayak.com). The bot was developed by a professional whose area of specialty is online data mining. However, the implementation was done by the researcher. The data collected by the customized bot was automatically stored in csv files. The variables stored included the hotel name, a unique hotel identifier, date of collection, targeted check-in and check-out dates, the minimum best available rate, star rating, online ratings, number of reviewers, and facilities and amenities existing in the hotels.

3.3.3 Pilot test

Validity and reliability are the two important attributes of data that researchers need to ensure before any meaningful analysis can be carried out. These desirable properties can be compromised when the data-gathering instrument or tool is not valid or reliable. Basically, a data-collection tool is said to be valid if it collects the true data it seeks to collect and reliable if it collects the same data consistently in a repeated measure (Saunders et al., 2009). In the literature, there are several potential threats to reliability and validity that have been identified (Robson, 2002; Saunders et al., 2009). According to Robson (2002), the potential threats to reliability include subject or participant error, subject or participant bias, observer error and observer bias. Also, Saunders et al. (2009) have indicated that the threats to validity include history, testing instrumentation, mortality, maturation and ambiguity about causal direction. Where these threats may exist, a suggestion is usually to conduct a pilot study to determine and correct them.

However, in this study, because the variables were unambiguously defined and the process of the data collection was automated, the identified threats to reliability and validity were largely minimized. Nonetheless, Allen and Wu (2010) caution that research designs involving software-based agent of data collection on the Internet using shopbots may be subject to unexpected and systematic biases, and insufficient data to support market analysis. For this reasons, a pilot test was conducted twice, for 14 days, in the month of April to assess the feasibility of the main data collection and identify the potential problems that could be encountered so that the appropriate strategies could be put in place to overcome them when they occur (van Teijlingen & Hundley, 2002).

As anticipated, the results of the pilot test turned out to be useful in many ways. First it brought to light that the original scheme for the data collection which was intended to crawl the data twice every day could be modified to once in a day since intra-day price changes were less pervasive. Second, the pilot test enabled the researcher to determine the appropriate time at which the data collection could be done with minimal interruptions. Consequently, the bot was set to collect the data within 10:00am -11:00am every day and to maintain consistency in the time frame. Last but not least, through the pilot test, it was experienced that because the bot was customized to kayak.com, certain changes or updates in the website could results in failure of the bot to run, thereby resulting in the collection of wrong the data.

Based on the first-hand experience with the pilot test and the possible challenges that were identified from the literature, a combination of strategies similar to Bergen, Kauffman and Lee (2005) were instituted to ensure that the issues identified by Allen and Wu (2010) did not harm the reliability of this research. First, a collateral measure was instituted to examine the contents of the saved files for completeness and reasonableness. On few occasions during the main data collection, these validation processes prompted the need for remedial actions to be taken which were accordingly done expeditiously. Second, a confirmatory process of manually collecting data for a random sample of 10 hotels was done and compared with the data obtained from automated process. The comparisons yielded the same results.

3.3.4 Main data collection

The main data collection for this study was conducted for a period of six consecutive months, starting from April 26, 2014 and ending on October 28, 2014. According to the monthly statistics on hotel room occupancies generated by the HKTB, this period encompassed the peak (high demand, i.e. July and August) and off-peak (low demand, i.e. September and October) seasons, making the data comprehensive enough to capture seasonality. Within the period, the target dates for the data collection were all Tuesdays and Saturdays (see Table A1 in the appendix for the schedule of the dates). The target dates are defined as the dates for check-in. This means that the structure of the data in this study was in the form of a panel where data on the hotels were collected over several periods. The advantage of working with a panel data is that it allows researchers to longitudinally analyse a cohort of cross sectional units and to capture differences due to time and other factors.

Consistent with other studies (Abrate et al., 2012; Schamel, 2012), Tuesdays and Saturdays were purposively selected as the typical days that could represent weekday (business guests) and weekend (leisure customers) businesses respectively. For each day, there were 26 target dates for the data collection. However, the actual data collection in respect of each target date started 8 days in advance, the period within which prices are expected to change regularly. This procedure followed similar practices by Abrate et al. (2012) and Balaguer and Pernías (2013), but for an extended period of time. As a matter of clarification, the scope of the study was on the seven days prior to check-in; however, the initial prices (taken 8 days in advance) were collected so that they could be used to control for the load factor in each period (i.e. the prevailing occupancy) at the property which otherwise could not be obtained directly for lack of access.

3.4 Data preparation and management

After the data collection, it was necessary to prepare the data for analysis. In this regard, several actions were taken. First, the sample was restricted to three-, four- and five-star hotels. As in other studies (Tso & Law, 2005; Zhang et al., 2011), this was done to reduce the substantial price differences among the selected sample. Second, all serviced apartment hotels were also excluded from the sample because they did not either have the standard double room or could not be booked for a single night stay. The third group of hotels that were also excluded were resorts. These were considered to be significantly differentiated (or near monopolies) from other hotels and could have different pricing behaviour that cannot be justifiably mixed with other hotels for a pricing study of this nature.

Lastly, the unbalanced panel data were restructured into balanced panel to be able to appropriately address the objectives of study. This action involved omitting some hotels from the sample and must be properly justified because of its tendency to create *survivorship* bias especially when the retained cross sectional units do not represent the omitted ones. Before proceeding to further explain the justification for constructing a balanced panel, the possible factors that may account for an unbalanced panel are worth examining. In a multi period surveys, unbalanced panel usually arises because some individuals may drop out. In finance data for example, mergers and acquisitions can also lead to an unbalance panel situation.

However, in the context of this study, the unbalanced panel was most likely to be caused by unavailability of rooms on the third-party channels. That is to suggest that, on particular dates that a hotel's rooms were sold out on the third-party channels, there was bound to be no price available for that hotel. The implication of this was that, for a hotel that might have rooms to sell within any given period of the data collection, it was more reasonable to assume that its pricing behaviour could be related to other hotels with room availability and not those hotels that have sold out. Thus, the study was interested in modelling the interaction between neighbouring hotels with online prices and therefore the unbalanced panel had to be reconstituted to a balanced panel.

Perhaps, the more compelling reason for constructing a balanced panel was to be able to use the "xsmle" command in Stata for estimating spatial interactions between a hotel and its neighbours (one of the objectives of this study) which does not apply to unbalanced panel (Belotti, Hughes & Mortari, 2013). An alternative way of using the same command on unbalanced panel with the "mi" prefix (Belotti et al., 2013) would have required that the missing price data were imputed. However, this alternative was discounted as less desirable because the condition of "missingness", as already explained, is an important factor that can influence pricing behaviour due to the implied limited choices of hotels that will be available to consumers in the event of a sold-out and therefore needed to be maintained in the data.

At the end, a balanced panel of 126 hotels involving 26 Saturdays and 26 Tuesdays (i.e. 3276 observations each) was obtained for the analysis. The relevant variables for each model as explained in section 3.5 were generated. Where some transformations were required, they were done accordingly.

3.5 Econometric models' specification

Specifying econometric models often involves a series of decisions about the models' content (Baum, 2006). Among other decisions, the researcher has to identify the set of explanatory variables to include in the model so as to avoid the problems of omitted variables bias. In most cases, prevailing theories might suggest which variables to include and therefore researchers can depend on extant theories to make this first decision toward model specification. The second decision is how the selected variables enter the model. That is, what functional form best represents the true relationship between the dependent and independent variables. In other words, should the model be estimated in levels, log-linear (semi-log) form, log-log (double-log) or polynomial in one or more of the variables? Unfortunately, these questions may not be answered from theory. In the absence of any cues from theory, some of the functional forms may be chosen for the estimation, after which comparative statistic and misspecification tests are applied to select the most suitable specification.

Proceeding along these lines, three econometric models were specified to examine separately the three objective of this study. The explanatory variables were drawn from existing literature, following the functional specifications in past studies and testing for their appropriateness (Balaguer & Pernías, 2013; Borenstein & Rose, 1994; Hayes & Ross, 1998; Mantin & Koo, 2009). The econometric models are presented in the subsequent sections starting with the count data models.

3.5.1 Count data models

The analysis for the frequency of room rate change was conducted using count data model. Generally, count data models are among the family of limited dependent variable models that are applicable when the dependent variable is not continuous. More appropriately, it is applied when the dependent variable is a discrete variable generated from the process of counting. In such situations, because the dependent variable is not a continuous, Ordinary Least Squares cannot be used and count data models are the most appropriate. Count data models have a number of alternative specifications (see Cameron & Trivedi, 2013; Winkelmann, 2003 for a comprehensive discussion on the variety of models).

However, the Poisson and the negative binomial models have emerged as the most commonly applied in empirical research (Hilbe, 2007). These two models differ in their assumptions of the conditional mean and variance of dependent variable. In the Poisson model, the conditional mean and variance of the distribution are assumed to be equal (i.e. equidispersion assumption) while in the negative binomial model, this assumption is relaxed (Greene, 2008). In particular, the negative binomial is designed to handle overdispersion in the data which arises when the variance is greater than the conditional mean. In practice, many empirical studies tend to use the negative binomial because the dependent variable is unlikely to be equally dispersed. However, distribution of the count data can be determined as a basis for choosing between the Poisson and negative binomial.

As a foundational building block, the Poisson regression model for a panel data can be expressed as follows:

$$Prob(Y = y_{it} \mid X_{it}) = \frac{\exp(\lambda_{it})\lambda_{it}^{\,y_{it}}}{\Gamma(1 + y_{it})} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where:

$$\lambda_{it} = \exp(\alpha_{it} + X_{it}'\beta) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (2)$$

$$E(y_{it} \mid X_{it}) = \lambda_{it} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (3)$$

$$Var(y_{it} \mid X_{it}) = \lambda_{it} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (4)$$

Where X_{it} is the vector of covariates and β is the set of parameters to be estimated. Often times, since the observed data will almost display overdispersion, the alternative specification of negative binomial is expressed similarly as the Poisson but with an introduction of a latent heterogeneity in the conditional mean of the Poisson model (Greene, 2008). Thus, the conditional mean is expressed follows:

$$E(y_{it} \mid X_{it}, \varepsilon_{it}) = \exp(\alpha_{it} + X_{it}'\beta + \varepsilon_{it}) = \lambda_{it}h_{it} \quad \dots\dots\dots\dots\dots. \dots (5)$$

Where $h_{it} = \exp(\varepsilon_{it})$ is assumed to have one parameter gamma distribution, $G\ (\theta, 0)$ with mean 1 and variance $\frac{1}{\theta} = k$ and a marginal negative binomial distribution:

$$Prob(Y = y_{it} \mid X_{it}) = \frac{\Gamma(\theta + y_{it})\, {r_{it}}^{\theta} (1 - r_{it})^{y_{it}}}{\Gamma(1 + y_{it})\Gamma(\theta)} \quad \ldots\ldots\ldots\ldots.\ldots.\ldots (6)$$

$$y_{it} = 0, 1, \ldots, \theta > 0, r_{it} = \theta/(\theta + \lambda_{it}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots (7)$$

$$Var(y_{it} \mid X_{it}) = \lambda_{it} + k{\lambda_{it}}^{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots.. (8)$$

$$h_{it} = \exp(X'_{it}\beta) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (9)$$

The dependent and independent variables used in both the Poisson and negative binomial models are defined in Table 3.2 with the corresponding references.

Table 3. 2: Definitions of variables for the count data model

Variable	Definition and operationalization	Operationalization	References
Frequency of price change (dependent variable)	The number of times the best available rate changes within the seven days preceding a target date for check-in (i.e. frequency of price change)	Discrete count of any price change (increase or decrease)	Cecchetti (1986); Powers and Powers (2001)
Occupancy	The proportion of the available rooms in a month sold by all hotels	Percentages	
Seller density	The number of hotels within 500m radius of a focal hotel	Count of hotels	Balaguer and Pernías (2013); Lewis (2008); Barron et al. (2004)
Chain	Independent or chain-affiliated	Dummy variable	Balaguer and Pernías (2013); Hung et al. (2010)
Star rating	The official star category of the hotel	Dummy variables	Becerra et al. (2013); Hung et al. (2010)
Size	The number of rooms in a hotel	Categorized into three groups and operationalized by dummies	Becerra et al. (2013); Hung et al. (2010)
Class	The classification of a hotel according Luxury, Upper Upscale, Upscale, Upper Midscale	Dummies	Canina et al. (2005)
District	The official administrative district assigned to a hotel by the Hong Kong Tourism Board	Dummy variables	Balaguer and Pernías (2013)
Distance to attractions	The sum of the distance between a hotel and the top ten tourist attraction	Mean Harversine distance in Kilometres (km)	Becerra et al. (2013); Zhang et al. (2011)
Distance to airport	The straight line distance between a hotel and the Hong Kong International airport	Harversine distance in Kilometres (km)	Balaguer and Pernías (2013)
Distance to MTR	The straight line distance to nearest Mass Transit Railway station	Harversine distance in Kilometres (km)	Balaguer and Pernías (2013) Zhang et al. (2011)

3.5.2 *Binary choice models*

The analysis to predict the direction of room rate change (increase or decrease) was conducted using logit and Probit models. Specifically, binomial logit and probit models were estimated for the likelihood of an aggregate increase in room rate versus no change or aggregate decrease and the likelihood of an aggregate decrease in room rate against no change or aggregate increase in room rate. In mathematical form, the panel logit model was expressed as follows:

$$Prob(Y_{it} = 1 \mid X_{it}) = \frac{e^{X_{it}'\beta}}{1 + e^{X_{it}'\beta}} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(10)$$

Where X_{it} is the vector of covariates and β is the set of parameters to be estimated. The probit model specification follows similar function except that the cdf is normally distributed with zero mean and one standard deviation. The dependent and independent variables used in both the logit and probit models are defined in Table 3.3 together with their corresponding references.

Table 3. 3: Definitions of variables for the logit model

Variable	Definition and operationalization	Operationalization	References
Dynamic price pattern (dependent variable)	The aggregate change in the best available rate within the seven days preceding a target date for check-in	Binary for aggregate increase and aggregate decrease in room rate	Chen and Schwartz (2008)
Occupancy	The proportion of the available rooms in a month sold by all hotels	Percentages	
Seller density	Number of hotels within 500m radius of a focal hotel	Count of the hotels	Balaguer and Pernías (2013); Lewis (2008); Barron et al. (2004)
Chain	Independent or chain-affiliated	Dummy variable	Balaguer and Pernías (2013); Hung et al. (2010)
Star rating	The official star rating/category of the hotel	Dummy variables	Becerra et al., (2013); Balaguer and Pernías (2013)
Size	The number of rooms in a hotel	Categorized into three groups and operationalized by dummies	Becerra et al. (2013); Hung et al. (2010)
Class	The classification of a hotel according Luxury, Upper Upscale, Upscale, Upper Midscale	Dummies	Canina et al. (2005)
District	The official administrative district assigned to a hotel by the Hong Kong Tourism Board	Dummy variables	Balaguer and Pernías (2013)
Distance to attractions	The sum of the distance between a hotel and the top ten tourist attraction	Mean Harversine distance in Kilometres (km)	Becerra et al. (2013); Zhang et al. (2011)
Distance to airport	The straight line distance between a hotel and the Hong Kong International airport	Harversine distance in Kilometres (km)	Balaguer and Pernías (2013)
Distance to MTR	The straight line distance to nearest Mass Transit Railway station	Harversine distance in Kilometres (km)	Andersson (2010); Zhang et al. (2011)

3.5.3 Spatial modelling

The analysis of price dispersion follows a spatial approach. In spatial analysis, the main concern is that there are spatial dependence and spatial heterogeneity among units. This assumption is based on the fact that spatially-dependent units may be connected in a certain way that requires analyst to recognize and operationalize that connectivity. According to Zhang et al. (2011) room prices for hotels are supposed to be spatially autocorrelated due to the following reasons. First, because of the same or similar location, neighbouring hotels tend to share similar developmental goals and requirements. Second, because of similar development history, neighbouring hotels have similar structural characteristics such as dwelling size, interior and other service facilities. Third, neighbourhood hotels share location amenities such as restaurants, shopping mall and same security services and facilities. A fourth point that can be added is that because hotels in the same location may be targeting the same customers, they tend to react to each other's price.

In general, geographic contiguity and distance are the standard ways to operationalize the connectivity among spatial units (Drukker, Peng, Prucha & Raciborski, 2013). This is usually done by constructing a weight matrix based on either contiguity or inverse distance. Constructing the weight matrix is an important step in spatial modelling. Appropriate to this study, the inverse distance approach was used to construct the weight matrix. In the literature, five spatial models are commonly discussed. These include Spatial Autoregressive (SAR), Spatial Autoregressive Model with Autoregressive disturbances (SAC), Spatial Error Model (SEM), Spatial Durbin Model (SDM) and the

Generalised Spatial Panel Random Effects Model (GSPRE). Essentially, these models discuss the cross-unit interactions involving the dependent variable, the exogenous variables and the disturbances. The differences in the various models are related to their underlying assumptions in term of interaction (refer to Table 3.4 for the distinctions).

Following a panel structure, a general specification of for spatial models will be:

$$Y_{it} = \alpha + \tau Y_{it-1} + \rho \sum_{j=1}^{n} W_{ij} Y_{jt} + \sum_{j=1}^{n} X_{itk}\beta_k + \sum_{k=1}^{k} \sum_{1}^{n} W_{ij} X_{jtk}\theta_k + \mu_i + \gamma_t + \nu_{it} \quad \text{..........(11)}$$

With:

$$\nu_{it} = \lambda \sum_{j=1}^{n} M_{ij}\nu_{it} + \epsilon_{it} \quad \dots\dots (12)$$

$$i = 1, \dots, n \quad t = 1, \dots, T$$

In matrix notation, the above equations can be written more compactly as:

$$Y_{it} = \tau Y_{it-1} + \rho W Y_{it} + X_{it}\beta + DZ_{it}\theta + a_i + \gamma_t + \nu_{it} \quad \dots\dots (13)$$

$$\nu_{it} = \lambda E \nu_{it} + \mu_{it} \quad \dots\dots (14)$$

$$i = 1, \dots, n \quad t = 1, \dots, T$$

Where μ_{it} is a normally distributed error term, W is the spatial matrix for the autoregressive component, D is the spatial matrix for the spatially lagged dependent variables, E is the spatial matrix for the idiosyncratic error component. a_i is the individual fixed or random effect and γ_t is the time effect. For static models, $\tau = 0$ and dynamic models $\tau \neq 0$ (Yu et al., 2008). When some restrictions are imposed on the above specification, the different spatial models are derived as follows:

Table 3. 4: Spatial models

If:	Then the model is:
$\theta = 0$	Spatial Autoregressive Model with Autoregressive disturbances (SAC)
$\theta = 0$ and $\lambda = 0$	Spatial Autoregressive Model (SAR)
$\theta = 0$ and $\rho = 0$	Spatial Error Model (SEM)
$\lambda = 0$	Spatial Durbin Model (SDM)
$\theta = 0$, $\rho = 0$ and $\mu_i = \phi \sum_{j=1}^{n} W_{ij}\mu_i + \eta_i$	Generalised Spatial Panel Random Effects Model (GSPRE)

The selection of any of these models is guided by statistical test of the coefficients. In this study, the selection of the spatial model proceeded in five steps: first an OLS model was estimated and compared against the SEM. Rejection of the appropriateness of the OLS model led to the comparison between the SEM and SAR. The outcome of this comparison led to the comparison of the SDM and the SAC. Eventually, the SDM was found to fit the data better. As in previous studies relating to the implicit prices of houses (Brasington & Hite, 2005), the SDM has also been found to yield more appropriate results than the other models.

In this study, dynamic price dispersion is operationally defined as the accumulation of variations in best available rate over a booking period of seven days, measured prior to check-in (Mantin & Koo, 2009). From the literature review, there are number of acceptable ways of measuring price dispersion. Table 2.1 provided a comprehensive list of the various indices. Basmann, Hayes and Slottjie (1994) have shown that the rankings of the various indices are often consistent. However, due to the relative advantages and disadvantages of each index, there appears to be no single index that has emerged as a standard index that is universally applicable (Hayes & Ross, 1 998).

Besides, the analysis provided by Hayes and Ross (1998), using multiple indices validate the usefulness of adopting multiple indices. In view of this, most empirical studies often use more than one index to reduce the possibility of having index-specific results and enhance the robustness of their findings (Borenstein & Rose, 1994; Gerardi & Shapiro, 2009; Hayes & Ross, 1998). Following this tradition, this study also adopted three alternative measures of price dispersion, which have been widely applied in previous studies (Baye et al., 2004; Borenstein & Rose, 1994; Chellappa, et al., 2011; Gaggero & Pigga, 2011; Gerardi & Shapiro, 2009). These indices were range, standardized range and coefficient of variation. Although other measures like variance or standard deviation have also been used in some previous studies (see Dahlby & West, 1986; Pratt et al., 1979), the coefficient of variation is preferred over these indices because it is able to distinguish between two firms with the same variance in price but different average prices (Chellappa et al., 2011). The dependent and independent variables used in the spatial models are defined in Table 3.5 together with the corresponding references.

Table 3. 5: Definitions of variables for the spatial model

Variable	Definition and operationalization	Operationalization	References
Coefficient of variation (dependent variable)	The extent of variation in the best available rate of a hotel's room rate relative to its average daily rate in the seven days prior to a target date for check-in	$CV = \frac{\sqrt{\frac{\sum_1^7 (p_{it} - \overline{p_{\imath m}})^2}{n-1}}}{\overline{p_{\imath m}}}$ Where $\overline{p_{\imath m}} = \frac{\sum_1^n p_{im}}{n}$	Chellappa et al., (2011)
Demand	The total number of rooms sold by all hotels	Natural logarithm of the demand	
Price	The starting best available rate for a hotel	Natural logarithm of the price	
Frequency of price change	The number of times the best available rate changes within the seven days preceding a target date for check-in	Discrete count of any price change (increase or decrease)	Powers and Powers (2001)
chain	Independent or chain-affiliated	Dummy variable	Balaguer and Pernías (2013); Hung et al. (2010)
Size	The number of rooms in a hotel	Natural logarithm of the size	Becerra et al. (2013); Balaguer and Pernías (2013)
Star rating	The official star category of the hotel	Dummy variables	Becerra et al. (2013); Hung et al. (2010)
Class	The classification of a hotel according Luxury, Upper Upscale, Upscale, Upper Midscale and Midscale	Dummies	Canina et al. (2005)
District	The official administrative district assigned to a hotel by the Hong Kong Tourism Board	Dummy variables	Balaguer and Pernías (2013)
Distance to attractions	The sum of the distance between a hotel and the top ten tourist attraction	Mean Harversine distance in Kilometres (km)	Zhang et al. (2011)
Distance to airport	The straight line distance between a hotel and the Hong Kong International airport	Harversine distance in Kilometres (km)	Balaguer and Pernías (2013) Zhang et al. (2011)
Distance to MTR	The straight line distance to nearest Mass Transit Railway station	Kilometres (km)	Andersson (2010); Zhang et al. (2011)

3.6 Estimation techniques

Broadly, the main estimation technique for all the specified models was regression techniques. In particular, the Maximum Likelihood Estimation (MLE) was employed considering the model specifications and the Stata commands that were used. Bearing in mind the spatial nature of the framework, spatial heteroscedasticity and autocorrelation consistent estimates were obtained.

3.7 Post estimation diagnostics

After estimating regression outputs, it is natural to test if the results meet the assumptions underlying the estimation techniques that were used. For most regression results, the typical diagnostics tests that are performed included independence of the regressors (i.e. no multicollinearity), normality of the residuals, constant variance of the error terms (no heteroscedasticity) and uncorrelated residuals (i.e. no serial correlation). In this study, these tests were also carried out to ensure the validity of the regression outputs. The results of the diagnostics tests are reported in the appendix. For almost all the regression output, the underlying assumptions were satisfied, assuring that the results are valid and can be relied upon.

The term multicollinearity is used to refer to the problem where two or more variables used in a regression are near perfect linear combination of each other. The primary concern with linear combinations of variable is not whether it exists or not but how high or severe it is. Where the degree of collinearity is high (above certain threshold), multicollinearity becomes seriousness because it inflates the standard errors of the coefficients estimates, which can render otherwise significant coefficients insignificant. The check for multicollinearity in this study was done by examining the pairwise correlations among the variables and the Variance Inflation Factor (VIF). The correlation matrix and VIFs are reported in Table 1A in the appendix. When the thresholds of correlation coefficients less than 0.5 and VIF of not more than 10 (Myers, 1990) are applied to the results, it is found that the results do not call for serious concern.

In regression analysis, the residual from the estimates are expected to be normally distributed. This requirement when satisfied allows for hypothesis testing to be validly conducted because the t-statistics and p-values become valid. In this regard, the normality of the residuals were tested because hypotheses testing were conducted to determine which variables are significant in determining online pricing behaviour. The results of the numerical tests which are reported in the appendix were conducted using the Shapiro-Wilk (swilk) test and corroborated by the Kernel density plot and P-P(Q-Q) plots of the regression standardised residual graphs (see Figure A2 in the Appendix for the graphs). Overall, the distributions of the residuals approximated the standard normal distribution. Based on swilk test, the null hypothesis of normality could not be rejected, implying that the residuals are normally distributed.

3.8 Summary of the chapter

This chapter has presented all the methodological issues pertaining to the study. In the first section, the chapter discussed the research design which involves descriptive strategies and causal techniques. The unit of analysis has also been explained followed by an outline of the research procedure which addressed all the important methodological issues such as population and sampling, procedure for data collection, sources of data and pilot testing to ensure validity and reliability. In the next section, the econometric models adopted for the causal analyses were specified, taking into account the conceptual framework. Consistent with prior studies, some of the econometric specifications followed a semi-log linear functional form while others were specified in level form due to the nature of the data. In addition, the chapter has also provided detailed explanations on how the variables in the models were operationalized and estimated. In the final section, the various diagnostics tests that were conducted to ensure that results were valid and reliable were also explained.

CHAPTER 4: FINDINGS AND DISCUSSION

4.0 Introduction

This chapter presents the findings and discussion. The presentation is organized into seven major sections. The first section describes the composition of the sample in terms of age categories, star rating and operation – independent versus chain. The second section presents the spatial distribution of the sampled hotels. The goal of this presentation is to demonstrate the extent of agglomeration or clustering within the market and the corresponding demand situation in the various locations. In the third section, the summary statistics of the relevant data are presented. The fourth, fifth and sixth sections are devoted individually to the presentation of the findings relating to the three objectives of the study, which are: a) to measure the frequency of price change online and analyse the factors influencing it in the Hong Kong hotel market; b) to determine the patterns of price change online and examine the influencing factors in the Hong Kong hotel market; and c) to quantify the size of dynamic price dispersion and identify the factors that determine its magnitude in the Hong Kong hotel market. In each of these sections, the empirical results are presented in three sequential order: the descriptive analysis, the regression results and the discussion of the findings. The discussion of the results of each objective are annexed to their findings because the analytical methods underlining the results are different. In the final section, a summary is provided to conclude the chapter.

4.1 Composition of sample

Table 4.1 shows the composition of the sample according to age groups (years), size categories (number of rooms), star rating, mode of operation and class. Noticeably, these attributes are categorical or grouping variables and are therefore appropriately described with frequencies and percentages. From the results, it can be noted that the sample has a mix of hotels in different age categories, demonstrating hotels that were established early and lately. That is, while most of the hotels (35.71%) have been in operation for more than 20 years, a significant number of them (28.57%) have also been in operation for less than five years. On the face of this distribution, it can be inferred that, with regard to the number of hotel establishments, the hotel industry may be considered to be more competitive within the recent past five years than it was 10 to 20 years ago.

Table 4. 1: Composition of sample

Variables	N=126	%
Age(years)		
Less than 5 years	36	28.57
5 to 9 years	30	23.81
10 to 20 years	15	11.9
More than 20 years	45	35.71
Size (rooms)		
Small hotels (≤ 100)	23	18.25
Mid-sized hotels (101-300)	38	30.16
Large-sized hotels (> 300)	65	51.59
Star rating		
3-star	30	23.81
4-star	76	60.32
5-star	20	15.87
Operation		
Chain Management	59	46.83
Independent	67	53.17
Class		
Midscale	40	31.75
Upper Midscale	31	24.6
Upscale	24	19.05
Upper Upscale	11	8.73
Luxury	20	15.87

Notes: star rating is from kayak.com; size classification is based on McCann and Vroom (2010) study; class information is obtained from STR and it is a ranking of hotels based on Average Daily Rates (ADR). From the highest to the lowest ADR, the rankings are luxury, upper upscale, upscale, upper midscale, midscale and economy.

In terms of size categories, the sample contains disproportionately more large-sized hotels (51.59%) than small-sized (18.25%) and mid-sized hotels (30.16%). Similarly, the distribution of the sample according to star rating is also unbalanced. Four-star hotels constitute the majority (60.32%), followed by 3-star (23.81%) and 5-star (15.87%). In a sense, this relatively high number of 4-star hotels in the sample bodes well for a pricing study of this nature. This is because by virtue of 4-star hotels' ranking (as in, rated between 3- and 4-star hotels), their position places them in a more competitive pricing situation to face pressures from the other two categories.

Regarding operation, the sample is relatively more balanced between independent hotels (53.17%) and chain-affiliated hotels (46.83%). However, the distribution of the hotels according to class, as reported by STR, is also uneven. Midscale hotels account for the majority (31.75%), followed by upper midscale (24.6%), upscale (19.05%), luxury (15.87%) and upper upscale (8.73%). The classification by STR is based on the Average Daily Rate (ADR), generated by the hotels and could be regarded as a form of price rankings. With this ranking, luxury hotels are at the top, with the highest ADRs, followed by upper upscale, upscale, upper midscale, midscale and economy, in descending order. Against this backdrop, the composition of the sample can be viewed as skewed to the low-end of the market (albeit not the lowest-end since no economy hotels were reported in the sample) than the high-end.

4.2 Spatial distribution of sample and demand in different locations

As a service industry offering products that must be consumed at the place of production, spatial location is one of the most important factors that can be expected to influence the pricing behaviour of hotels. Existing studies in Geography (Egan &

Nield, 2000; Shoval, 2006), marketing (Baum & Haverman, 1997; Urtasun & Gutiérrez, 2006) and economics (Kalnins & Chung, 2004) have argued that due to the strategic importance of location to hotels' business, there is a natural tendency for hotels to agglomerate or cluster around each other or some attractive locations where productive and consumer advantages abound (Canina et al., 2005; Urtasun & Gutiérrez, 2006).

Previous empirical studies on spatial structure of hotels and tourist accommodations have confirmed that hotels' location tends to be non-random but exhibit clustering or agglomeration (Chou, Hsu & Chen, 2008; Egan & Nield, 2000; Urtasun & Gutiérrez, 2006; Yang, Wong & Wang, 2012). These studies further argue that hotel developers select their location according to tourism infrastructure and spatial factors such as urban development, traffic conditions, public goods and services, and agglomeration densities. In Hong Kong, where the current study was conducted, Li et al. (2015) have recently investigated the spatial relationships between hotels and land use types, attractions, and transportation facilities. Among others, the authors concluded that the distribution of upper-grade hotels is significantly related to commercial land types and the number of attractions surrounding the hotels.

As an illustration of the spatial agglomeration or clustering amongst the sample for this study, the geographical coordinates (longitudes and latitudes) of the hotels are used to depict their spatial locations in Figure 4.1. Although this graphical display is not the only way to demonstrate spatial agglomerations (maps could also be used), it remains one of the most effective means to allow patterns to be discovered quickly.

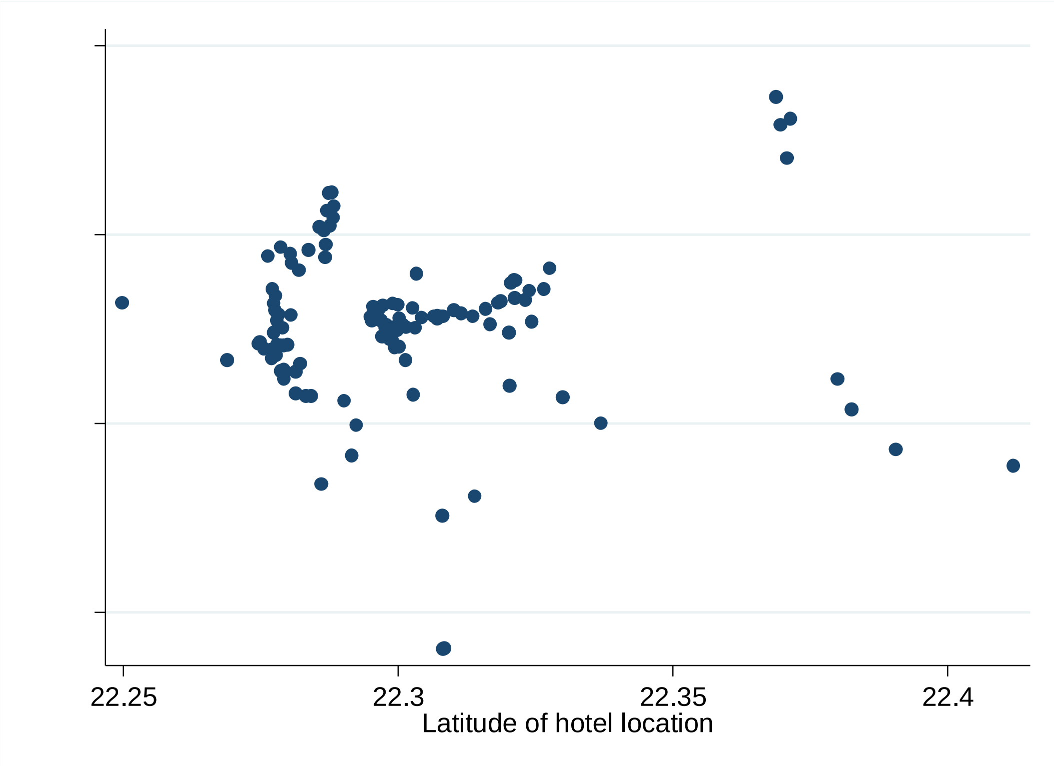


Figure 4. 1: Spatial distribution of sampled hotels

From the visual display in Figure 4.1, it is clear that spatial agglomeration is evident amongst the sample. To aid a better understanding of the clustering, the distribution of the sample according to administrative districts, as assigned by the HKTB, is presented in Table 4.2. These districts, comprising Central & Western, Eastern & Southern, Yau Ma Tei & Mong Kong, Wanchai, Tsim Sha Tusi, New Territories and Other Kowloon, can be considered as a close approximation of the clustering.

Table 4. 2: Distribution of sampled hotels according to district

Administrative district	**N**	**Percent**
Central & Western	18	14.29
Eastern & Southern	8	6.35
New Territories	14	11.11
Other Kowloon	11	8.73
Tsim Sha Tsui	30	23.81
Wanchai	27	21.43
Yau Ma Tei & Mong Kok	18	14.29

As shown in Table 4.2, the district with the highest concentration of hotels is Tsim Sha Tsui. This district has more than 23% of the sample, followed closely by Wanchai district which has 21.43% of the hotels. The Eastern & Southern administrative district has the lowest percentage of hotels (6.35%). Relating the spatial distribution to demand, the occupancy rates for the various districts during the data collection period (May to October) are provided in Table 4.3.

Table 4. 3: District level demand

Administrative district	**Occupancy (%)**						
	May	***Jun***	***Jul***	***Aug***	***Sep***	***Oct***	**Average occupancy**
Central & Western	88	85	87	89	83	86	86.33
Eastern & Southern	86	88	91	91	82	86	87.33
New Territories	91	93	97	97	89	93	93.33
Other Kowloon	80	85	94	94	80	87	86.67
Tsim Sha Tsui	88	88	91	92	86	89	89.00
Wanchai	88	87	90	90	85	86	87.67
Yau Ma Tei & Mong Kok	90	92	96	96	89	89	92.00
Average occupancy	87.29	88.29	92.29	92.71	84.86	88	88.90

From the results, it can be observed that, for the entire period of the data collection, occupancy rates were generally high for every district, averaging 88.90. However, hotels in the New Territories, and Yau Ma Tei & Mong Kok (which are not the central business districts anyway) consistently outperformed their counterparts in other districts with occupancy rates averaging 93.33% and 92% respectively.

Interestingly, the central business district (i.e. Central & Western) has the lowest average occupancy rate (86.33%), which may be explained by the premium pricing policy of hotels that are usually located in the central business district. Temporally, the data also show that the peak and off-peak months were August and

September respectively. As will be expected, the spatial and temporal patterns can be explained by several factors including sales and marketing efforts as well as pricing policies (Jeffrey, 1985; Pearce & Grimmeau, 1985). However, in the absence of information on these variables at the district level, it is believed that the markets being served by these hotels and locational differences partly account for the variations in demand.

4.3. Summary statistics of the data

Having described the composition of the sample, attention is now turned to describing the data for the analysis. The descriptive statistics are summarized in Table 4.4. Different from the strategies that were used to describe the categorical variables in Table 4.1, the data in this section are summarized with mean and standard deviation. These statistics are considered to be the most appropriate for summarizing continuous and discrete variables which apply to the data in this section. In addition to the mean and standard deviation, the minimum and maximum values for each variable are also reported to show the range of values for each variable.

For easy reference, the variables are grouped into price-related, hotel characteristics, market conditions, and location-related attributes. Also, in order to exploit the richness of the panel data, the aforementioned summary statistics are reported for “overall”, “within” and “between” so as to highlight the variations in the data “across time and units”, “within units over time” and “between units across time” respectively.

Table 4. 4: Summary statistics of the variables

Variables	Variation	Mean	Std. Dev.	Min	Max
Price-related variables					
Starting room rate	Overall	1541.66	971.10	300.00	6980.00
	Between		873.02	751.96	5066.29
	Within		432.20	-44.71	5010.45
Average room rate	Overall	1607.94	971.65	324.75	7391.00
	Between		874.35	780.13	5206.65
	Within		430.77	44.86	4877.90
Frequency of room rate change	Overall	4.17	1.83	0.00	7.00
	Between		0.83	1.40	5.69
	Within		1.63	-1.10	8.90
Range of room rate	Overall	419.17	424.05	0.00	3660.00
	Between		148.16	186.00	1242.33
	Within		397.54	-698.16	3716.74
Price ratio (highest over lowest)	Overall	1.34	0.31	1.00	3.86
	Between		0.12	1.08	1.63
	Within		0.29	0.72	3.88
Standardize range (as a fraction of mean)	Overall	0.27	0.22	0.00	1.54
	Between		0.08	0.07	0.46
	Within		0.21	-0.18	1.57
Coefficient of variation (CV)	Overall	0.11	0.09	0.00	0.69
	Between		0.03	0.03	0.18
	Within		0.08	-0.08	0.69
Hotel characteristics					
Size (rooms)	Overall	363.23	257.00	13.00	1615.00
	Between		258.01	13.00	1615.00
	Within		0.00	363.23	363.23
Age (years)	Overall	15.48	15.15	0.00	94.00
	Between		15.21	0.00	94.00
	Within		0.00	15.48	15.48
Market conditions					
Demand	Overall	56995.29	4999.99	42256.00	63023.00
	Between		0.00	56995.29	56995.29
	Within		4999.99	42256.00	63023.00
Occupancy	Overall	86.62	7.59	64.20	95.70
	Between		0.00	86.62	86.62
	Within		7.59	64.20	95.70
Seller density	Overall	6.22	5.42	0.00	19.00
	Between		5.44	0.00	19.00
	Within		0.00	6.22	6.22
location-related variables					
Distance to city centre	Overall	3.83	3.84	0.20	25.40
	Between		3.86	0.20	25.40

	Within		0.00	3.83	3.83
Distance to HK international airport	Overall	24.62	2.84	8.51	33.52
	Between		2.85	8.51	33.52
	Within		0.00	24.62	24.62
Distance to the nearest train station (MTR)	Overall	0.48	0.51	0.06	3.27
	Between		0.51	0.06	3.27
	Within		0.00	0.48	0.48
Shortest distances between hotels (km)	Overall	0.46	1.21	0.20	9.67
	Between		1.21	0.20	9.67
	Within		0.00	0.46	0.46
Longest distances between hotels (km)	Overall	24.94	2.61	15.81	31.17
	Between		2.61	15.81	31.17
	Within		0.00	24.94	24.94

NB: N = 6552, n = 126, T = 52

As a useful way to proceed with the interpretation of the results in Table 4.4, the summary statistics relating to the "overall" variation for each variable will be considered. These statistics will be interpreted as summarizing the entire dataset for each variable. However, for the "within" and "between" variations, it will be sufficient to pay attention to only the values of the standard deviation. In that regard, a zero standard deviation for a "within" variation will be given the interpretation that the variable in question does not change over time (i.e. time-invariant). Similarly, a "between" zero standard deviation will be interpreted as a variable whose values do not differ across the units.

Referring to Table 4.4, the first variable under "price-related" is *starting room rate*. This variable refers to the initial room rates which were collected on the 8th day prior to check-in. The purpose of this variable is to serve as a proxy for load factor, controlling for the accumulated demand (or occupancy) before the start of data collection for any target date. Across all hotels and time, the mean value for this variable is HK$1,542 and the maximum and minimum values are HK$6,980 and HK$300 respectively. Contrasting these values with the corresponding values for the *average room rate* in respect of the seven days prior to check-in, marginal increases can be noted. For instance, the mean value for the *average room rate* is HK$1,607.94 but the maximum and minimum values are HK$7,391 and HK$324.75 respectively. Primarily, these differences suggest that dynamic adjustments in room rates occurs in the Hong Kong hotel market, which causes the average room rate to increase as the target date for check-in approaches.

For the *frequency of room rate change,* the overall mean value of 4.17 signifies that within the seven days before check-in, room rates could be expected to change almost four times with a standard deviation of 1.83. In terms of the size of change, the overall average for the *range of room rate* (i.e. the differences between the highest and lowest rates) for all hotels is approximately HK$420, meaning room rates could be lowered or increased by an average of HK$420. In the extreme case(s), the maximum value for the range of room rate was HK$3,660, suggesting that, in some instance(s), the room rate for certain hotel(s) could be raised or lowered by HK$3,660. The zero minimum value for the range also suggests that for some target date(s), the room rate remained constant, hence no dynamic price adjustment was implemented.

Expressed differently, the summary statistics on *price ratio* convey similar meaning as the range but the price ratio allows the differences to be interpreted in terms of percentages. That is, the mean price ratio of 1.34 indicates that, on the average, room rate could be increased or decreased by 34%. Similarly, for the maximum price ratio of 3.86, it means that, in some case(s), room rates were adjusted by almost 300%. The summary statistics on the *coefficient of variation* (CV) capture the dispersion or variability in the room rate around the means. The overall mean value of 0.11 suggests that on average, room rates can be expected to deviate (+ or -) from their means by almost 11%.

In terms of hotel characteristics, the *size* and *age* variables show that the smallest and largest hotels have 13 and 1615 bed rooms respectively while the youngest and oldest hotels are less than one year and 94 years respectively. The mean values for the size and age variables are approximately 364 rooms and 16 years with significant variability of about 257 and 15.15 standard deviations respectively. As explained previously, the within standard deviation of zero corresponding to size confirms the relatively fixed capacities of the hotels.

Regarding the statistics on market conditions, the total *demand* for hotel rooms ranged between 42,256 and 63,023. Corresponding to these, the minimum and maximum *occupancy* rates were 64.2 and 95.7 respectively with an average of about 86.62. The indication of these statistics is that demand for hotel rooms in Hong Kong is relatively high when compared to other markets. With localized market defined as a radius of 500m (i.e. 0.5km) about a focal hotel, the average number of localized competitors within the enclave is approximately 6.22 with a standard deviation of 5.42. This average number of 6 competitors is consistent with findings of earlier studies that indicate that hotels typically identified between 4 and 8 competitors for competitive analysis (Canina & Enz, 2006; Clark & Montgomery, 1999; Li & Netessine, 2012). For robustness check of the results, the definition of localized market was varied for a lower radius of 400m and higher radius of 600m. The corresponding mean number of competitors for these definitions are 4.52 and 7.98 competitors (not reported in Table 4.3).

The last set of variables described in Table 4.4 is the location-related attributes (i.e. distance to airport, distance to the nearest train station, shortest and longest distances among hotel). These variables show summary statistics that can be used to describe location attractiveness or accessibility and more importantly the spatial density of the hotels. To comment briefly on some of these statistics, one can note that the shortest distance between any two hotels is about 200m (0.2km) while the longest distance is about 31.2km. The average distance between any two hotels is 460m. This average distance constitutes one of the reasons for deciding on 500m radius as the definition for the localized market. The other reason was to ensure that the average number of competitors will be between 4 and 8 in order to reflect the reality as found in other studies. For all the distance related variables, it can also be noticed that the standard deviations for the within variations are zeros because the geographical locations of the hotels and tourism infrastructure are fixed.

4.4 Empirical results of the frequency of price change

The results in this section are organized into three parts. The first part provides a descriptive analysis of the frequency of price change, using percentages and bar graphs. For the purpose of determining the frequency of price change, a price change was deemed to have occurred when there is a difference in price from one day to the next (Berka, Devereux & Rudolph, 2011). The second part of the results examines the factors that influence the frequency of price change, using the output from a negative binomial regression technique. The last section discusses the major findings in relation to existing knowledge and practice.

4.4.1 Descriptive results

As the first step towards the analysis of the frequency of room rate change, the descriptive analysis here is conducted to demonstrate the degree to which dynamic pricing is implemented in the Hong Kong hotel market and to highlight any differences relating to its practice on Saturdays and Tuesdays. Combining all the data, 6,552 observations comprising 26 Saturdays and 26 Tuesdays for 126 hotels were generated. For each of these observations, there were seven data points corresponding to the seven days prior to a target check-in date (i.e. one of the 26 Saturdays or 26 Tuesdays).

Out of the seven data points, the number of successive price changes were generated as a count variable with values from 0, 1, 2, 3, 4, 5, 6, and 7; where 0 means no price change within the 7-day period and 7 means that price change every day. The frequency of each count expressed as a percentage of the total observations is presented in Figure 4.2. The corresponding data to Figure 4.2 are shown in Table 1A in the appendix.

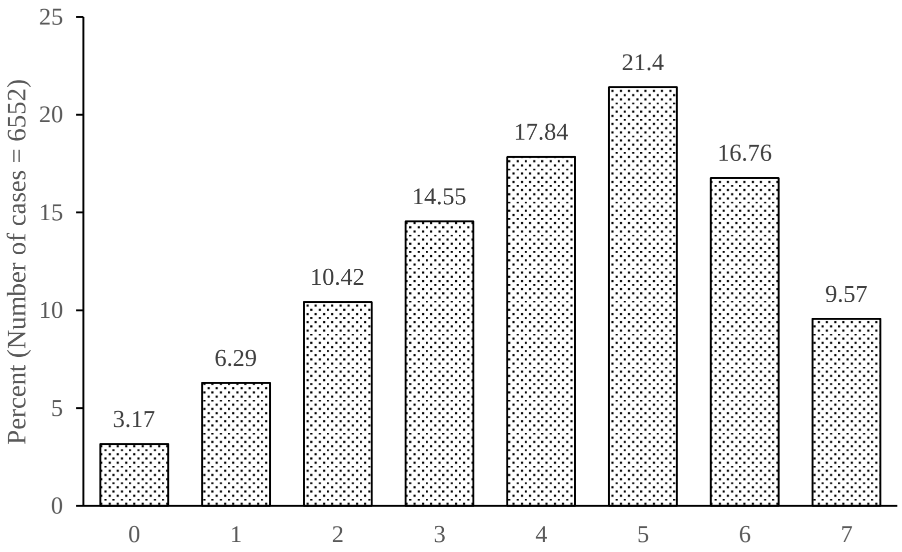


Figure 4. 2: Frequency of price changes

In sum, the distribution displayed in Figure 4.2 clearly demonstrates that dynamic pricing strategy was implemented by the hotels in this study. In most of the cases (96.83%), prices were dynamically adjusted at least once within the 7-day windows. In the few cases when prices were not adjusted (3.17%), a second level analysis confirmed that it was not the same hotels that were not adjusting their prices. Thus, a firm conclusion can be reached that all the hotels in the sample implemented dynamic pricing at one point in time or the other.

More importantly, the distribution also shows some fine details that shed lights on how frequent dynamic pricing strategy was implemented. For example, the modal frequency of price change is five (5), showing that out of the seven days, most hotels dynamically adjusted their room rates on five days. The average frequency of price change is about four (reported in Table 4.4), which is more than half of the days in the week. Furthermore, in more than 70% of the cases, the adjustments in price were done three to six times while in few cases (9.57%) the price adjustments were even done on a daily basis (9.57%). All these pieces of evidence sum up to suggest that dynamic pricing was quite frequent and prevalent.

To highlight the implementation of dynamic pricing on a weekday (Tuesday) and weekend (Saturday), the data were further analysed for each of these days separately. The results of these analyses are depicted in Figure 4.3 with the corresponding data presented in Table A2 in the Appendix.

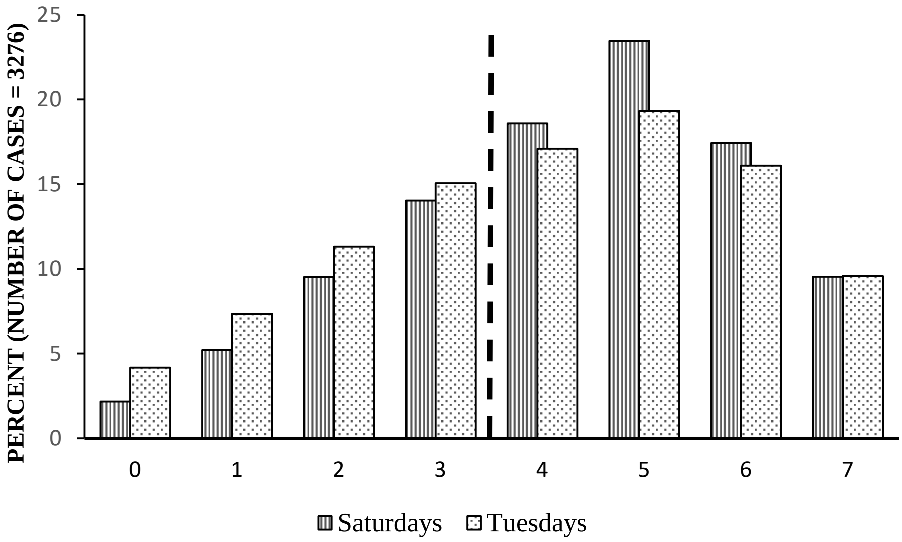


Figure 4. 3: Frequency of price change according to day

From the results presented in Figure 4.3, one similarity that is evident in the dynamic pricing on Saturday and Tuesday is that both pricing strategies exhibited relatively higher frequencies of price adjustments than low frequencies. That is, the sum of 4, 5, 6 and 7 changes are more than those for 0, 1, 2 and 3. This means that for both Saturdays and Tuesdays, dynamic price adjustments are more likely to be frequent (at least four-time adjustments).

However, the striking difference is that relative to Tuesdays' adjustments, most Saturdays' rates were associated with frequent adjustments. Similarly, with reference to the less-frequent adjustments, most Tuesdays' rate were adjusted less frequently than Saturdays. These differences can be noted from Figure 4.3 by comparing the height of the bar graphs to the left and right of the reference (broken) line. To the left of the reference line, there are more less-frequent changes occurring on Tuesdays than on Saturdays, while to the right, there are more frequent price changes occurring on Saturdays than on Tuesdays.

Explaining these subtle differences, two interpretations can be offered. On the one hand, the more frequent price changes on Saturdays can be interpreted to mean that because Saturday customers are predominantly leisure customers, with higher price sensitivity, most hotels have to indulge in frequent price adjustment to sell their rooms. This interpretation suggests that competition to sell rooms is perhaps keener on Saturdays than on Tuesdays and, as such, prices have to vary more frequently to deal with the intense competition. On the other hand, the more infrequent price changes on Tuesday can be interpreted to mean that perhaps demand on weekday is more stable than on weekend given that business customers' buying decisions are less spontaneous and more predictable.

4.4.2 Econometric results

As explained previously, dynamic price adjustment is found to be evident in the data. Thus, the need to identify the factors that determine the frequency of price change falls into place. The analysis presented in this section seeks to fill this need. As explained in the methodology, two alternative models could be used to identify the determinants of the frequency of price change: the Poisson model which assumes equidispersion in the dependent variable and the less-restrictive model of negative binomial, which allows for overdispersion. For most empirical data, the equidispersion assumption seldom holds. As such, researchers frequently use the negative binomial model, which anyhow yields similar results as the Poisson model if the dependent variable is not overdispersed.

For robustness checks, the model for the frequency of room rate change was estimated in this study with both the Poisson and Negative binomial assumptions. Qualitatively, the results from these estimations were largely identical and consistent. Table 4.5 reports the results of the negative binomial regression for the count of room rate change on Saturdays and Tuesdays (see Table A4 for the equivalent results from the Poisson model). Since the objective of this study was not to determine the effect sizes of variables, the reported coefficients are not marginal effects. Importantly, the coefficients were estimated with cluster robust standard errors.

Table 4. 5: Results of negative binomial regression

Variables	***Saturday***	***Tuesday***
Occupancy	0.0047***	0.0099***
	(2.69)	(10.02)
Seller density	0.0134***	0.0127**
	(2.58)	(2.16)
Chain	-0.0110	0.0045
	(-0.28)	(0.09)
4-star	0.0654	0.0287
	(1.40)	(0.54)
5-star	-0.0795	-0.195**
	(-1.00)	(-2.16)
Medium-sized (101-300 rooms)	0.0974*	0.0386
	(1.75)	(0.61)
Large-sized (more than 300 rooms)	0.134**	0.111
	(2.27)	(1.65)
Midscale	-0.124	-0.170*
	(-1.61)	(-1.92)
Upper midscale	-0.0216	-0.0972
	(-0.29)	(-1.12)
Upper upscale	-0.00555	-0.0875
	(-0.07)	(-0.95)
Upscale	-0.0300	-0.0523
	(-0.40)	(-0.60)
Eastern & Southern	0.0495	0.0692
	(0.54)	(0.67)
New Territories	-0.0087	-0.105
	(-0.07)	(-0.73)
Other Kowloon	0.0289	-0.0441
	(0.36)	(-0.49)
Tsim Sha Tsui	-0.0306	-0.0459
	(-0.41)	(-0.49)
Wan Chai	0.0462	0.0138
	(0.68)	(0.18)
Yau Ma Tei & Mong Kok	0.0826	0.0852
	(1.30)	(1.17)
Distance to Airport	0.00635	0.00791
	(0.75)	(0.81)
Distance to nearest train station	0.0745*	0.109**
	(1.75)	(2.23)
Mean distance to top attractions	-0.00569	-0.00168
	(-0.44)	(-0.12)
Constant	16.89***	16.03
	(49.48)	(0.09)
Log likelihood	-6494.5951	-6632.1052
Wald chi2	51.86***	137.48***
Lnalpha_constant	-3.803***	-3.462***
	(-20.85)	(-20.53)
Ln_r_constant	19.99	19.22
	(0.13)	(0.11)
N	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Overall, the results in Table 4.5 indicate that, on either Saturdays or Tuesdays, the frequency of room rate change is influenced by the level of demand as measured by the average occupancy rate, the size of hotel as determined by the number of rooms, the quality rating of hotel as represented by the star rating, class of hotel as segmented by ADRs, accessibility to transport facility as proxied by distance to the nearest train station, and the degree of localized competition as captured by seller density within a localized market.

However, the coefficients of the location dummies for the various districts are not statistically different from the comparison group (Central & Western), signifying that the frequency of room rate change does not systematically differ according to districts. As expected, the significant coefficients have different signs and, therefore, their respective interpretations are discussed subsequently. In view of the fact that coefficients are not marginal effects, the interpretations shall be limited to just the signs and not the magnitudes.

4.4.2.1 Effects of market structure variables

In a leading explanation why firms may exhibit heterogeneity in changing prices, Rotemberg and Saloner (1987) developed a market power explanation. In their explanation, the authors suggest that the frequency of price change by a firm is related to whether the firm operates in a less competitive market or a more competitive one. In a less competitive market, price are expected to change less frequently than in a competitive market. The justification offered by the authors is that firms in a less competitive markets face a demand curve perceived to be steeper, which lowers the net benefit of changing prices. Extending the market-power reasoning to a continuum of markets (monopoly to perfect competition), Hannan and Berger (1991) arrived at similar predictions as Rotemberg and Saloner (1987) that the frequency of room rate change increases with an increase in competition.

To determine the effect of market structure on the frequency of room rate, two variables were included in the model to capture the overall demand situation (i.e. occupancy levels) and the extent of localized competition (i.e. spatial seller density) faced by each hotel. Although the popular measures of competition such as the HHI and concentration ratio could not be used due to the inaccessibility of sales data at the property level, the appropriateness of using seller density as a measure of competition is grounded on the issue of spatial agglomeration, which is symptomatic of the hotel industry. In spatially-dependent markets like the hotel industry, the need for defining localized competition has been emphasized (Baum & Mezias, 1992). Consequently, previous researchers have found seller density to be significant in their pricing studies (Balaguer & Pernías, 2013; Barron et al., 2004; Lewis, 2008).

From the regression outputs in Table 4.5, the effects of occupancy and seller density on the frequency of room rate change are statistically significant and consistent with a priori expectation. In both the Saturday and Tuesday regression outputs, occupancy has a significant positive effect on the frequency of room rate change, indicating that as demand increases relative to a fixed supply, the frequency of room rate change also increases. This finding confirms that adjustments in room rate are dynamically related to demand. Regarding seller density, the regression results also indicate a positive effect of seller density on the frequency of room rate change. This suggests that as the number of localized competitors increases, the frequency of room rate change by a hotel which is surrounded by a higher number of competitors also increases.

A straightforward interpretation of the positive effect of seller density on the frequency of room rate change is that because higher seller density is an indication of higher competition, frequency of room rate change is dependent on the market structure. In this sense, the finding can be seen as supporting the prediction of Rotemberg and Saloner (1987) that more competitive markets have higher frequency of price changes than less competitive ones. Another justification that can be offered in support of this finding is that, in a localized market with fewer hotels, room rates are likely to change less frequently because it is easier for competitive pricing to be avoided while in markets with many hotels, the individual hotels may be setting their prices competitively.

As a robustness check of the sensitivity of the results to the definition of a localized market, the estimation of the negative binomial and Poisson models were replicated for seller densities corresponding to two radii – 400m and 600m – which narrowed and widen the geographical scope of the localized market definition. The results from these estimations are qualitatively similar to those offered in Table 4.5, with the same set of statistically significant and insignificant variables (see Tables A5 and A6 in the appendix for the alternative results). In all the regression estimates, the effect of seller density on the frequency of room rate change remained positive.

4.4.2.2 Effects of hotel characteristics

In the offline market, the frequency of price change has also been explained by a number of cost-of-price-adjustment theories. According to these theories, price adjustment is not costless; and the cost may involve menu cost (including the physical cost of changing price), managerial cost (including information-gathering cost, decision-making cost, and internal communication cost), and customer cost (which includes cost of presenting new prices to customers and cost of negotiation with customers that may not be convinced with the logic or justification for the price change) (Blinder et al., 1998; Carlton, 1986; Cechetti, 1986; Kashyap, 1995; Lach & Tsiddon, 1996; Mankiw & Reis, 2002; Okun, 1981; Sheshinski & Weiss, 1992; Zbaracki et al., 2004). Using these theories, scholars have predicted that a profit-maximizing firm facing cost-of-price-adjustment will change its price less frequently than a similar firm with no or lower cost-of-price-adjustment.

Relating the extant theories of price adjustment cost in the offline market to the digital economy, Kauffman and Lee (2007) have opined that the frequency of price changes in the digital economy can still be influenced by cost-of-price-adjustment. The authors explain that although technology makes price adjustment and communication to customers almost technically costless; because it may simply involve database updates which can be programmed, the managerial cost of price adjustment can still be significant. In support of this viewpoint, a couple of studies have demonstrated that even among Internet retailers of homogeneous products, there is substantial heterogeneity in the frequency of price change so as to believe that cost of price adjustment is not extinct (Chakrabarti & Scholnick, 2007; Bergen et al., 2005). In Bergen et al.'s (2005) study, for example, the authors found that price changes on Amazon were less frequent than Barnes and Noble even for identical products.

Prominent as the cost-of-price-adjustment theories are, it has rather been difficult to directly measure the associated costs accurately at the firm level, owing to the lack of cost-related data (Blinder et al., 1998). In view of this difficulty, some empirical studies have used indirect proxies to capture the possible cost of price adjustment by noting firm-to-firm differences that can influence price adjustments.

For example, in a study of price changes in groceries stores, Powers and Powers (2001) adopted Okun's (1981) theory of customer market and implicit contract (which is consistent with customer cost theory) to explain why large grocers may change prices less frequently. Using this theory, the authors argued that "to the extent that all grocers experience the same proportion of their customers switching to rivals when they change their prices, larger grocers lose greater number of their customers"(p.401) and are thus less likely to change their price frequently.

In another study, Buckle and Carlson (2000) argued for the relationship between firm size and frequency of price change. According to the authors, larger firms are bound to change price more often than smaller firms because menu costs falls systematically as firm size increases. Following this tradition, hotel-to-hotel differences are used to represent cost-of-price-adjustment in this study and are captured by four differentiating categorical variables: chain affiliation, star rating, size and class of hotel. These variables have been used similarly to represent differentiation among hotels in various empirical studies (Abrate et al., 2012; Balaguer & Pernías, 2013; Becerra et al., 2013; Ropero, 2011).

The regression coefficients of the aforementioned variables, as reported in Table 4.5, show that except for chain affiliation, frequency of room rate change is statistically related to star rating, size and class of hotel but on different booking days. In the case of star rating, the significant effect is on Tuesdays but not Saturdays. Precisely, the significant coefficient is in respect of 5-star hotels and negative, which indicates that, in comparison to 3-star hotels, 5-star hotels are expected to have lower frequency of price change on Tuesday bookings. This finding partly supports Abrate et al.'s (2012) argument that the highest star rankings give hotels the opportunity to maintain a more stable pricing policy over time, especially when the general price pattern is supposed to be declining.

As a support for the lower price fluctuation by 5-star hotels, Blinder et al. (1998) and Allen (1988) have argued that in an environment where quality of service is not observable, price rigidities can be based on the theory of quality signalling, which pertains to the luxury product market. According to this theory, firms' rigidity to decrease price can be explained by the fear that customers may incorrectly interpret the price reductions as a reduction in quality. In light of this argument, it can be asserted that perhaps the 5-star hotels have lower frequency of room rate change because they seek to maintain some image effect.

Furthermore, the results show that size of hotel has a significant influence on the frequency of room rate change on Saturday but not on Tuesdays. Specifically, the coefficients of medium- and large-sized hotels are both positive indicating that in comparison to small-sized hotels these hotel have higher frequency of room rate change. This finding contradicts the finding of Powers and Powers (2001) in which the authors found evidence to support the position that large groceries change price less frequently. In the case of this study, it is believed that the finding is inconsistent with the customer market and implicit cost theories offered by Powers and Powers (2001) to support their finding because unlike other industries where customers have frowned upon price adjustment, the practice of revenue management pricing is becoming more acceptable to hotel customers (Choi & Mattila, 2004; Kimes, 2002).

Another explanation that can justify the finding of this study is that unlike the groceries shops in Powers and Powers' (2001) study, that sell durable and non-durable goods, hotels rooms are completely perishable and intangible. Therefore, it can be reasoned that, all things being equal, the aggregate opportunity cost for not selling many rooms would be relatively higher for medium- and large-sized hotels than it would be for small-sized hotels. This implies that the relatively high opportunity cost can be expected to drive the medium- and large-sized hotels to change price more frequently so as to minimize or avoid the potential loss of revenue. In other words, it is being suggested that medium- and large-sized hotels might be changing their room rate more frequently so as to fill up capacity, because not doing so might cause them to lose more revenue than their counterpart small-sized hotels.

Another interpretation that can be offered to justify the positive relationship between the frequency of room rate and size of hotel is perhaps due to the economies of scale argument. This explanation is credited to Buckle and Carlson (2000), who argued that the menu cost of changing price falls systematically with size. Thus, for medium- and large-sized hotels, the average cost of price adjustment cost may be lower, which places them at advantageous positions to be able to change price more frequently than small-sized hotels.

The variables for the class of hotel do not show much significant differences. The only significant difference is between midscale and luxury hotels. The statistically significant negative coefficient of midscale hotels dummy variable indicates that, in comparison with luxury hotels, the frequency of room rate change by midscale hotel is lower. This finding appears to be at variance with a priori expectation as suggested by Abrate et al. (2012) that high-quality high-price hotels are expected to maintain price stability. Nonetheless, it is not hard to justify this finding, considering that the competitive pressures to vary price by midscale hotels could be lessened by the absence of economy hotels.

4.4.2.3 Effects of location attributes

The hospitality literature is replete with a number of studies that underscore the importance of spatial location in the operation of hotels (Baum & Haveman, 1997; Egan & Nield, 2000; Kalnins & Chung, 2004; Molina-Azorin et al., 2010; Sasser et al., 1978; Shoval, 2006; Urtasun & Gutiérrez, 2006). Sasser et al. (1978), for example, explain that hotel's location influences customers' purchase decision because hotel products must be consumed at the location of production. Egan and Nield (2000) supplement that the location of hotel can determine its clientele. As an example, Lee and Jang (2011) explain that hotels in the vicinity of airports may cater to the needs of business people and travellers who anticipate late arrivals, overnight transfers and early departures due to their high accessibility to the airport.

Apart from linking hotel location to customers' purchase decision, the significance of location in the pricing decision of hoteliers has also been underscored in the literature (Andersson, 2010; Becerra et al., 2013; Chen & Rothschild, 2010; Lee & Jang, 2011; Monty & Skidmore, 2003; Thrane, 2007; 2005). In several studies of this ilk, researchers have determined the premium placed on location accessibility and attractiveness in setting prices. The overwhelming majority of the studies have concluded, based on the hedonic pricing theory, that because hotel products is a composite of private and public tourism infrastructure, their prices are influenced by proximity to transport system (airport and bus/train station), tourism attractions and central business district, in addition to the existing facilities and amenities in the establishments (Andersson, 2010; Balaguer & Pernías, 2013; Becerra et al., 2013; Carvell & Herrin, 1990; Thrane, 2005).

Perhaps, the most influential article on the importance of location is Hotelling (1929). In his paper, Hotelling argued that location can become a source of differentiation among sellers in spatial competition. Extending this theory to the context of this study, four location-related attributes commonly used in previous hedonic pricing studies were included in the model to explain the frequency of room rate change. These were the administrative district in which hotels are located, hotel's distance to international airport, distance to the nearest train station and average distance top tourist attractions. Of these, only distance to the train station was significant. In both regression outputs (Saturdays and Tuesdays), the coefficient of distance to the nearest train station was positive and significant, indicating that hotels that are located farther from the train station change their prices more frequently.

With regards to the effect of distance to the nearest train station on the frequency of room rate change, it is thought that because proximity to a transport system would normally be regarded a desirable attribute by customers, it implies that hotels that are located closer to the train station might be enjoying locational advantage which does not require frequent price changes to fill their rooms. Conversely, it can also be argued that for hotels that are located farther away from the train station, frequent price adjustment might just be one of the strategies that are employed to attract an array of customers that otherwise would not be drawn to a disadvantageous location. In its totality, the significance of distance to the nearest train in regression output indicates a kind of premium attached to this mode of transportation due to its convenience in Hong Kong.

The other location-related variables were not significant probably because of the small size of Hong Kong and the spatial agglomeration of the hotels. Taking distance to the international airport for example, the airport is on an island quite distant from the districts where the hotels cluster, thus, proximity to the airport does not become a significant differentiating variable. By the same argument, proximity/distance to tourist attraction does not influence the frequency of room rate. The insignificance of these variables could also be related to the fact that Hong Kong has a highly convenient transport facilities which give hotels fair access to the potential tourism market without needing extra cost for inaccessibility (Li et al., 2015)

From the foregoing analysis, the major conclusion to be drawn here is that, whereas demand and seller density affect the frequency of room rate change on Saturdays and Tuesdays in a similar manner, the effects of hotel characteristics on the frequency of room rate change differ according to the day of the week. On Tuesdays, 5-star hotels are expected to have lower frequency of room rate change compared to 3-star hotels but no such systematic difference exists on Saturdays. Also, on Saturdays, medium- and large-sized hotels have higher frequency of room rate change than small-sized hotels but this difference does not apply to Tuesdays.

4.4.3 Discussion

The results offered in the previous two sections have shown some interesting findings that are worthy of contextualizing in the body of knowledge and practice. Basically, the findings have indicated that within seven days prior to checking in a hotel, room rates are dynamically adjusted according to the demand situation. In most of the price observations (96.83%), prices were dynamically adjusted at least once within the 7-day window. However, the modal and mean frequencies of price adjustment were 5 and 4 respectively. Also, there were also few cases when prices were not adjusted at all (3.17%). As demonstrated through the regression analysis, these frequencies of price change were influenced by occupancy rate, the number of localized competitors, the size of the hotel and distance to the nearest train station.

Ideally, the findings of the frequency of room rate change could be enriched by relating them to similar studies in the hospitality literature. However, the dearth of such studies in the hospitality literature (exception being Abrate et al., 2012; and Ropero, 2011) makes it expedient to extend the discussion of the findings to other industries (e.g. groceries, books, newspapers, banks etc.) and disciplines (e.g. economics and marketing) where there is abundant literature. Moving in this direction, the consistencies and inconsistencies to be noted between the findings of this study and existing theories and empirical studies are as follows.

Compared to the two earlier studies in the hotel industry that have investigated dynamic pricing (Abrate et al., 2012; Ropero, 2011), the frequency of room rate change in this study appears to be more frequent and widespread (i.e. 96.83% of the observation showed price adjustment). In the study conducted by Ropero (2011), 20.4% of the 572 hotels and tourists apartments observed in the Spanish hotel market were found to have varied their rate during the 12-week period that they were studied. For almost 1,000 hotels in eight European capital cities that were monitored for 90 days, Abrate et al. (2012) also reported that 46% and 71% of the hotels were changing their prices during the last week to checking in on Tuesday and Saturday respectively.

Although the finding on the percentages of hotels implementing dynamic pricing as reported in the studies of Ropero (2011) and Abrate et al. (2012) may be regarded as dated, the comparison could also be usefully interpreted as a mark of an increasing adoption and practice of dynamic pricing in recent years. With this interpretation, it is important to add that the findings do not suggest that all hotels implement dynamic pricing in a similar fashion. There are hotels that adjust their rates less frequently and others that adjust them more frequently, depending on their characteristics. In the larger context of revenue management, the significant influence of occupancy rate on the frequency of room rate change signifies that the practice of dynamic pricing in the Hong Kong hotel market is in accordance with the theory of RM. As posited by RM theory, hotels that are implementing dynamic pricing are expected to adjust their room rates over time in line with the demand and supply situation in the market.

The finding on seller density also confirms the market structure explanation of the reasons why firms may exhibit heterogeneity in changing their prices (Hannan & Berger, 1991; Rotemberg & Saloner, 1987). At the broader level, the finding also fits into the structure conduct performance theory of Mason (1949; 1939) and Bain (1951) in which it is predicted that the structure of a market determines the conduct of its firms (in this case the frequency of price adjustments). Consistent with this prediction and the market structure hypothesis, the positive causal effect of seller density on frequency of room rate change indicates that as the degree of localized competition increases, it increases the frequency of room rate change. This implies that hotels in a relatively denser locations tend to vary their room rate more frequently than those in sparsely populated location due to the heightened rivalry to sell among them. In other words, the frequent price adjustment can be interpreted to mean frequent reactions to the price of competitors.

Even though this study did not observe the cost of price adjustment directly, the relationship between the frequency of room rate change and the size of hotel appears to offer some partial evidence to suggest that managerial cost of price adjustment could still be important in explaining the heterogeneity of room rate change in an Internet distribution channel. As it emerged from the results, the frequency of room rate change was positively influenced by the size of hotel, which supports the argument by Buckle and Carlson (2000) that large firms are bound to change price more often than smaller firms because menu cost tends to decrease systematically with increasing firm size. In a study of dynamic pricing policies of hotel establishments in an online travel agency, Ropero (2011) avers that price adjustment cost for larger establishments are lower.

The negative effect of star rating on the frequency of room rate change also seems to confirm the theory of quality signalling, which suggest that in an environment where quality of service is not observable, highest-quality offering firms may be reluctant to lower their price for fear that this can be incorrectly interpreted as lowering quality (Allen, 1988; Blinder et al., 1998). Relating this finding to the empirical work of Abrate et al. (2012), some consistency can be noted. Abrate et al.'s (2012) study also revealed that hotels belonging to the high star category (4 and 5) maintained a more stable prices especially when the general price pattern was declining. In light of this consistency, it is guesstimated that, probably, high-star-rated hotels attempt to transmit a certain image of price stability to its customers.

Up to this point, the results discussed so far have some implications for customers and hotel practitioners. Three of such implications are identified and discussed as follows. The first implication for hotel practitioners is that, even though dynamic pricing has been observed in the Hong Kong hotel market, the frequency of temporal adjustment in room rate is independent of the district in which hotels operate. This means that as far as district of location is concerned, hotel practitioners do not have to hold any reservations about how frequent they can change their price. The significant factors for them to take into account are the number of hotels in their immediate environment and the overall market demand.

The second implication for hotel practitioners is that since room rates were found to change frequently as a result of dynamic pricing implemented by all the hotels, it can be inferred that customers may not be able to identify hotels that are selling at the lowest or highest price based on their past experience. The indirect consequence of the price adjustment is that the rankings of hotels keep moving up and down within the price distribution. Hence, hotel practitioners can continue to implement dynamic pricing strategy in accordance with demand conditions without fear of possible customer antagonization that may simply be triggered by dynamic pricing.

For customers, the identified relationships between the frequency of room rate change and hotel characteristics such as size and star rating can be used to determine the relative propinquity of having to pay higher or lower when booking a hotel belonging to a particular star category or size group. Especially, for customers who might wish to minimize the risk of having to pay higher for a room, this information can serve as a useful guide to their strategic decision-making. Importantly, the findings also reveal the differences in how frequent room rate changes on either a Saturday or Tuesday. This information can benefit leisure customers, who tend to stay on weekend, and business guests alike, who usually make reservations for a weekday.

4.5 Empirical results of the pattern of price change

Similar to the presentation on the empirical results of the frequency of room rate change, this section also proceeds in three parts. The first part presents the findings on the descriptive analysis showing the average direction of room rate change arising from the dynamic price adjustments. That is, whether the dynamic adjustments in the room rates result in an aggregate increase, aggregate decrease or no change. The second part is devoted to the econometric analysis identifying the factors that can predict the probability of either an aggregate increase or aggregate decrease in the room rate. The final part discusses the findings as they relate to existing literature and industry practice.

4.5.1 Descriptive results

The aim of the descriptive analysis in this section is to provide insights on the average direction of room rate change that will advance the understanding on dynamic pricing strategies of hotels in Hong Kong. Existing theories on dynamic pricing have indicated that, depending on the underlying modelling assumptions, the optimal dynamic price pattern can be increasing, decreasing, fluctuating or constant over time (Bitran & Mondschein, 1997; Feng & Gallego, 1995; Gallego & Van Ryzin, 1994; Su, 2007).

In one of the theoretical explanations of optimal dynamic price patterns, Su (2007) uses the composition of customers and patience (waiting cost) as the bases to explain why price pattern may be increasing or decreasing. In his exposition, Su (2007) contends that price will decrease over time when high-valuation customers are quite impatient to buy early at higher prices and low-valuation customers are sufficiently patient to wait for sales. On the other hand, price will increase over time when high-valuation customers are more patient than low-valuation customers.

In a study of dynamic pricing among European hotels, Abrate et al. (2012) suggest that Su’s hypothesis can simply be tested in the hotel industry by comparing price patterns on weekdays when business customers (high-valuation less-patient) are dominant to those on weekend when leisure customers are predominant. Their expectation is that, a dynamically decreasing pricing strategy will be implemented on weekdays while a dynamically increasing price strategy will be implemented on weekend.

Following their suggestions, the descriptive analyses in this section are carried out separately for the mid-weekday (Tuesday) and weekend (Saturday). However, prior to that, the combined data are also analysed to determine the overall direction of room rate change (i.e. aggregate increase/decrease/unchanged) without recourse to the target day of check-in. Figure 4.4 presents the result for the combined data.

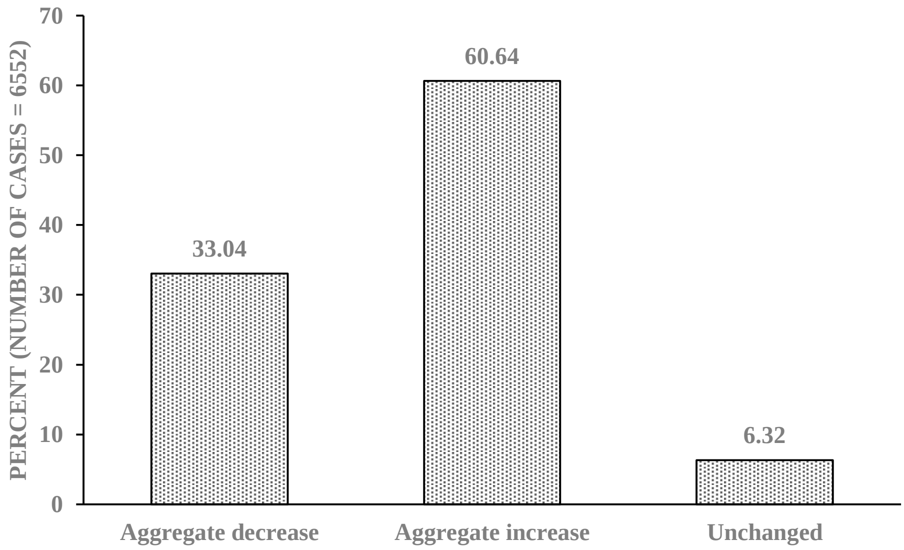


Figure 4. 4: Overall patterns of room rate change

From the above visual display, it is evident that a single pattern of price change did not exist for all the hotels throughout the sample period; there were cases of aggregate increase, aggregate decrease and no change, albeit not equally. In 60.64 percent of the observations, the aggregate room rate change was found to be an increase (positive) while in the rest of the cases, aggregate decrease (negative) and no change (zero) accounted for 33.04 percent and 6.32 percent respectively. What these figures signify is that the price pattern during the seven days prior to check-in is fluctuating and can result in an aggregate increase, aggregate decrease or no change. However, on the balance of probabilities, the dynamic price fluctuations will be more likely to result in an aggregate increase than an aggregate decrease which will also be more likely than a no-change. Thus, for customers who may be hedging against the perishability of room nights to secure last-minute deals (or lower prices), chances are that price could end up being higher than lower within the seven-day period prior to check-in.

Figure 4.5 displays the overall patterns of price change on a weekend (Saturday) versus mid-weekday (Tuesday). From this graph, consistent patterns similar to the observations in the entire dataset can be noted. That is, the average direction of room rate change on the Saturdays and Tuesdays reflect higher proportions of aggregate increase in room rate change (64.71% and 56.56%) than aggregate decrease (31.07% and 35.01%) respectively. However, in terms of price stability (i.e. the bars for unchanged), Tuesdays' rates appear to be more likely to be stable than Saturdays' rates.

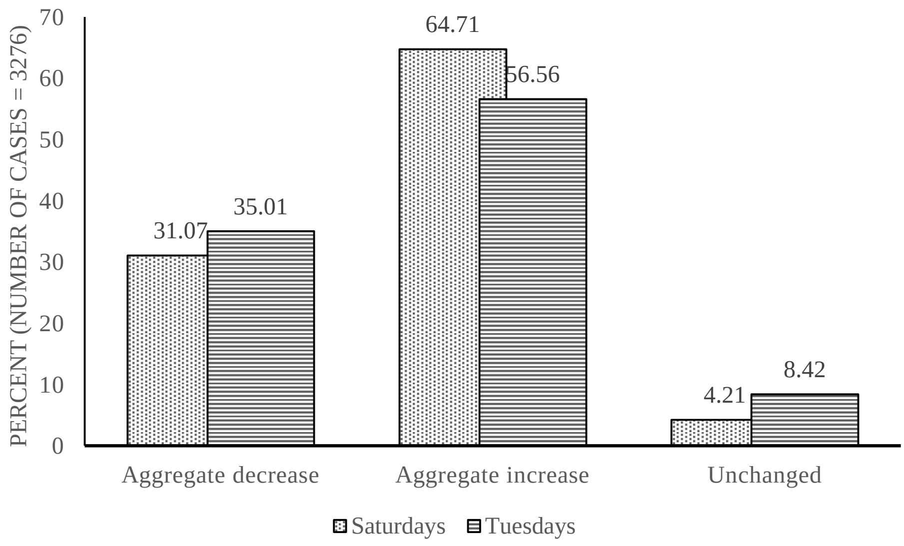


Figure 4. 5: Overall patterns of room rate change on Saturdays and Tuesdays

Examining the above results closely, two inferences can be made in relation to the aggregate increase or decrease on both days. First, it can be noted that, in respect of aggregate decrease, both customers booking against Saturdays and Tuesdays were likely to encounter price decreases; but, the incidences of an aggregate decrease were more towards the customers for Tuesdays than Saturdays. On the basis of this observation, it can be inferred that even though both leisure and business guests can expect to make some saving by engaging in last-minute booking, business guests stand a higher chance of the money-saving opportunity than leisure customers. Second, the percentage of aggregate increase was also in favour of Saturday, suggesting that although price increases were to be expected on either Saturdays or Tuesday bookings, the increments for Saturdays were more rampant than the increments on Tuesdays.

Summing up, these descriptive results can be seen to offer partial support for the findings of Abrate et al. (2012), who determined that the dynamic pricing structure of European hotels was related to the booking day and, by extension, the type of customers. In their study, the authors determined a decreasing dynamic pricing structure (equivalent to an aggregate decrease in this study) for a weekday; while on a weekend, the inter-temporal structure was increasing. Further, the authors noted that the proportions of their sample maintaining stable prices on Saturday and Tuesday were 7.1% and 10.9% respectively. By comparison, this is similar to the finding in this study, where the zero-change (i.e. bars for unchanged) on Tuesdays (8.42%) is higher than that on Saturdays (4.21%).

4.5.2 Econometric results

While the preceding section determined the patterns of price change, the analysis in this section focuses on identifying the factors influencing the probability of dynamic price adjustments, resulting in an aggregate increase in room rate or an aggregate decrease. For this goal to be achieved, two dependent variables (aggregate increase and aggregate decrease) were modelled as binary outcomes. In the case of the aggregate increase, the dependent variable was defined as one if the overall room rate change for a given period was increasing and zero otherwise. Similarly, the dependent variable in the aggregate decrease model was defined as one if the overall room rate change for a given period was decreasing and zero otherwise.

Considering the binary nature of the dependent variables, the models were estimated with both logit and probit techniques which yielded identical results (see Table A7 in the appendix for the results from the logit regression). The results of the probit regression are reported in Table 4.6. All the estimates were obtained with robust standard errors.

Table 4. 6: Probit regression results for aggregate increase/decrease in room rate

Variables	*Saturday* aggregate increase	*Saturday* aggregate decrease	*Tuesday* aggregate increase	*Tuesday* aggregate decrease
Occupancy	0.0916***	-0.0893***	0.0515***	-0.0390***
	(16.99)	(-15.90)	(17.98)	(-12.94)
Seller density	-0.00233	0.00990	0.0138	-0.00055
	(-0.26)	(1.03)	(1.19)	(-0.05)
Chain	-0.0559	0.0347	0.0737	-0.0714
	(-0.79)	(0.48)	(0.91)	(-0.85)
4-star	0.0191	0.0466	0.0590	-0.0414
	(0.20)	(0.48)	(0.68)	(-0.46)
5-star	0.0332	0.0266	-0.416***	0.191
	(0.20)	(0.15)	(-3.26)	(1.51)
Medium-sized (101-300 rooms)	0.204*	-0.120	0.254**	-0.266**
	(1.93)	(-0.94)	(2.44)	(-2.36)
Large-sized (more than 300 rooms)	0.120	-0.104	0.213**	-0.276**
	(1.18)	(-0.83)	(2.04)	(-2.56)
Midscale	0.368**	-0.301**	0.0370	-0.121
	(2.54)	(-1.99)	(0.28)	(-0.92)
Upper midscale	0.371***	-0.215	0.153	-0.262**
	(2.83)	(-1.59)	(1.19)	(-2.20)
Upper upscale	0.0400	0.110	-0.183	0.0899
	(0.28)	(0.76)	(-1.41)	(0.67)
Upscale	0.238	-0.0958	0.103	-0.184
	(1.56)	(-0.59)	(0.76)	(-1.37)
Eastern & Southern	-0.540**	0.599***	-0.176	0.304
	(-2.46)	(3.11)	(-0.81)	(1.47)
New Territories	-0.250	0.338	-0.487*	0.426
	(-1.00)	(1.25)	(-1.78)	(1.44)
Other Kowloon	-0.302*	0.417***	-0.469***	0.598***
	(-1.85)	(2.55)	(-3.10)	(3.97)
Tsim Sha Tsui	-0.0959	0.149	-0.293*	0.301*
	(-0.71)	(1.06)	(-1.95)	(1.90)
Wan Chai	-0.220*	0.247**	-0.222*	0.237*
	(-1.70)	(2.00)	(-1.66)	(1.78)
Yau Ma Tei & Mong Kok	-0.328*	0.375**	-0.223	0.362***
	(-2.67)	(2.96)	(-1.67)	(2.79)
Distance to Airport	0.0691***	-0.0710***	0.0562***	-0.0444**
	(3.72)	(-3.86)	(2.81)	(-2.20)
Distance to nearest train station	0.241***	-0.193**	0.0568	0.0829
	(3.20)	(-2.31)	(0.86)	(1.40)
Mean distance to top attractions	0.0236	-0.0264	0.0418	-0.0292
	(0.81)	(-0.86)	(1.45)	(-1.02)
Constant	-9.785***	9.223***	-5.880***	4.174***
	(-13.83)	(12.42)	(-10.19)	(6.93)
Log pseudolikelihood	-1902.1068	-1820.8886	-1971.7236	-1942.6874
Wald chi2	375.05***	349.38***	425.34***	276.79***
Lnsig2u_constant	-2.971***	-2.826***	-2.773***	-2.753***
	(-7.99)	(-8.43)	(-9.91)	(-9.64)
N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Looking at the four regression outputs reported in Table 4.6, there are a couple of ways by which the results can be paired up for meaningful comparisons and interpretations. One possibility is to consider the results for each day (both aggregate increase and aggregate decrease) and compare the significant variables. Another option is to consider the results of the aggregate increase for Saturday and Tuesday together and those for the aggregate decrease also together. Although each approach may have its own merits and points of emphases, the second approach portends to be more informative and conducive for highlighting any differences in the price patterns for customers making reservation for a Saturday-night stay or a Tuesday-night stay. Therefore, as far as possible, the subsequent analysis of the findings will follow the second option.

Contrasting the results from the aggregate increase in room rate for Saturdays with that on Tuesdays, it can be noted that the factors contributing to the probability of an aggregate increase in room rate on Saturdays are not exactly the same as those contributing to the probability of an aggregate increase in price on Tuesdays. Similarly, there are differences in the determinants of the probability of an aggregate decrease in room rate on both days. For the aggregate increase in room rate, the main difference is that, apart from the common significant variables which include occupancy, size and distance to the airport; the class of a hotel and distance to the nearest train station have significant influence on the probability of an aggregate increase in room rate on Saturday but not on the probability of an aggregate increase in price on Tuesday.

On the other hand, in addition to the common significant variables, star rating has significant influence on the probability of an aggregate increase in room rate on Tuesdays but not on Saturdays. With regards to the probability of an aggregate decrease in room rate, size of hotel is the additional significant variable for the Tuesday regression. However, for the Saturday regression, the distinctive significant variable is distance to the nearest train station. To proceed with the interpretation of the significant coefficients, it is worthwhile to state again that the coefficients are not marginal effects and therefore their magnitudes shall not be interpreted.

4.5.2.1 Effects of market structure variables

In all the four regression outputs reported in Table 4.6, occupancy rate was found to be a significant determinant of the probability of an aggregate increase in room rate and an aggregate decrease. Specifically, the effect of occupancy on aggregate increase in room rate in either the Saturday's or Tuesday's regression was positive; while in the aggregate decrease models, the effect was negative. These relationships mean that as occupancy rate increases, it makes the probability of upward adjustments in room rate more likely and the probability of downward price adjustments less likely.

Relating these findings to price determination theory in microeconomics, it is realized that whether dynamic price adjustments will result in an aggregate increase or decrease in the room rate depend on the demand and supply situation: as demand increases relative to a fixed supply, the probability of an aggregate increase (or decrease) becomes more (or less) likely all other things being equal. More than being regarded as confirmation of the price determination theory, the results can also be interpreted to mean that revenue management is applied correctly by the sampled hotels.

Although seller density was found to have a significant positive effect on the frequency of room rate change (as reported in the previous section), its effects on the probability of either an aggregate increase in room rate or an aggregate decrease in room rate is not significant. This finding implies that even though a hotel may vary its price in accordance with the degree of its localized competition, it does not change its price in a predetermined direction without recourse to the direction in which its competitors may be changing their prices. In effect what this means is that, the number of localized competitors *per se* does not determine whether hotels will dynamically adjust their room rate upward or downward but it affects the frequency of price adjustment over time. This finding appears to corroborate an early study by Ropero (2011) who concluded that an increase in the number of competitors in the Spanish hotel market affects neither the decision to raise, lower or maintain prices.

4.5.2.2 Effects of hotel characteristics

In this section, the effects of the main characteristics of hotels – chain affiliation, star rating, size and class – on the probability of having an aggregate increase in room rate or an aggregate decrease, as reported in Table 4.6, are examined in greater detail. Overall, the results indicate that the probability of an aggregate increase/decrease in room rate depends on the aforementioned characteristics except chain affiliation.

In respect of star rating, the results show that being a 5-star hotel makes it less likely for a hotel to have an aggregate increase in room rate when compared to 3-star hotels. The statistically significant negative coefficient for the 5-star dummy variable (i.e. -0.416) supports this results. Noticeably, the significance of 5-star dummy relates to only the Tuesday regression. The explanation for the less likelihood of 5-star hotels having an aggregate increase in room rate could be linked to the fact that the room rates of 5-star hotels in comparison to 3-star hotels may already be high to justify intermittent upward adjustments. However, the fact the significance of the variable is only on Tuesday can be related to the earlier observation that prices are less frequently adjusted on Tuesdays which means that price differences on this day could easily be recognized by customers and regarded as meaningful differentiation.

Further, the results in Table 4.6 show that being medium- or large-sized hotel increases the probability of an aggregate increase in room rate and lowers the probability of an aggregate decrease, especially on Tuesdays. On the face of it, this finding appears to be counterintuitive because the a priori expectation is that higher-capacity hotels should be more likely to reduce room rates in order to avoid or minimize the risk of running a lot of empty rooms. However, upon a second consideration, it can be rationalized that since occupancy rates are generally higher in Hong Kong, the principle of last availability of room can justify why medium- and large-sized hotels are more likely to have an aggregate increase in their room rates. Using this principle, it can be argued that in a market with high occupancy rate such as Hong Kong, the tendency for small-sized hotels to sell out and create additional demand for medium- and large-sized hotels could be a reason why medium- and large-sized hotel are more likely have an aggregate increase in room rates.

In terms of class, the results indicate that, compared to luxury hotels, midscale and upper midscale hotels are more likely to have an aggregate increase in their room rate on Saturdays (but not Tuesdays). A possible reason why the significant difference exists on Saturday and not on Tuesday is that; within metropolitan areas, it has been suggested that there is a greater degree of hotel substitution by leisure customers, who often book on weekends, than business customers, who tend to book on weekdays (Balaguer & Pernías, 2013). However to rationalize why midscale and upper midscale are more likely to have an aggregate increase in room rate when compared to luxury hotels, it is useful to recognize that the classification of hotels according to scale is a reflection of the ADR which is more closely interpreted as average price rankings.

Therefore, considering that midscale and upper midscale hotels have ADRs lower than luxury hotels, it can be argued that the prospect of an aggregate increase in room rate for the low-priced hotels (in this case the midscale and upper midscale) should be higher than the high-priced hotels (i.e. the luxury hotels). Hence, it is believed that midscale and upper midscale hotel are more likely to have an aggregate increase in their room rate than luxury hotel because the latter group may be hesitant to increase price further on an already relatively high-priced product for fear of possible customer switching.

4.5.2.3 Effects of location attributes

Regarding location attributes, the probability of an aggregate increase or decrease in room rate was also determined by the district in which hotels are located. Compared to hotels in Central & Western district (i.e. the central business district of Hong Kong), hotels that are located in Eastern & Southern, Other Kowloon, Wanchai, and Yau Ma Tei & Mong Kong are less likely to have an aggregate increase in their room rate but are more likely to have an aggregate decrease in their room rate. With these differences, customers looking to book a hotel without any preference for hotels in a particular district can be guided as to which districts are more likely to have an aggregate decreases in their rates.

As the central business district of Hong Kong (i.e. Central & Western district) where the mix of customers is likely to be in favour of high-valuation business guests, it is not surprising that hotels in other districts are less likely to have an aggregate increase in their room rate when compared to their counter in the central business district. The theoretical support for this finding can be gleaned from the variant of mono-centric hotel location model provided by Egan and Nield (2000) in which the authors identify the spatial hierarchy of different hotel types within an urban destination. In their model, it is predicted that luxury hotels prefer to be located within the city centre so as to attract their clientele, the affluent and the affluent business travellers. With this prediction, it is considered reasonable that hotels located outside of the central business districts are less likely to have aggregate increase in their room rate because their clientele, unlike those for hotels located in the central business districts, are not likely to be as affluent and therefor may have lower willingness to pay more.

Besides the district dummies showing significant differences, the precise locations of hotels with reference to the international airport and nearest train station were also significant in determining the probability of an aggregate increase or an aggregate decrease in room rate. The effects of these variables on the probability of an aggregate increase in room rate were positive on the one hand and negative for the probability of an aggregate decrease in room rate on the other hand. This means that hotels that are located farther away from the international airport or train station were more likely to increase their room rate and less likely to decrease their rates. This finding is rather surprising. The expectation was that proximity to these modes of transport should give an advantage to the proximal hotels to be more likely to increase their room rate and less likely to decrease their room rate. For want of any theoretical justification, it is reasoned that perhaps being farther away from the transport hub is a form of spatial differentiation which contributes to premium pricing of a sort.

It is also interesting to note that distance to tourist attractions does not have statistical influence on the probability of an aggregate increase or decrease in room rate. This may also be explained by the highly convenient transportation system in Hong Kong which does not require extra arrangements on the part of hotels to access the tourism markets. Perhaps, this observation can also explain why the effect of distance to the train station is only significant in determining price pattern on Saturdays but not on Tuesdays because tourists may simply care about accessibility to the transport system and not necessarily the proximity of their hotels to the attractions.

4.5.3 Discussion

The results presented in the previous section have revealed that different pattern of price adjustments can occur in Hong Kong hotel market. On both Saturdays and Tuesdays, the dynamic price adjustments most frequently generate an aggregate increase in room rates (60.64%) than an aggregate decrease (33.04%) or a zero-change (6.32%). In the airline industry, Lott and Roberts (1991) have argued that late bookers are charged higher price because the price includes the opportunity cost arising from the airlines' risk of having empty seats. Applying this reasoning to the hotel industry, similar arguments can be extended to justify the aggregate increases in room rate close to a target date for check-in. However, a counter argument can also be advanced to support aggregate decreases in the room rate. That is, prices may be decreased to avoid/minimize revenue loss from empty room (i.e. the opportunity cost of not selling room).

The econometric analysis of the pattern of price change has also revealed that occupancy rate, star rating, size and class are among the significant determinants of the probability of an aggregate increase/decrease in room rate. The other significant factors that affect the overall pattern of price change are the administrative district of the hotel, distances to the airport and proximity to the train station. The precise effects of these variables are related to the day for which hotels are being booked, implying that hoteliers take into account the characteristic of their target customers before deciding to raise or lower their rates. Not surprisingly, seller density does not determine the probability of an aggregate increase/decrease in room rate. This should not be misinterpreted to mean that hotels do not factor into their decision to raise or lower price, the direction in which their competitors are changing their prices. Rather, it is the number of localized competitors that simply does not predict the probability of an aggregate increase or aggregate decrease. The relationships of these findings to existing knowledge are discussed subsequently.

In the general theory of price determination in microeconomics, the prevailing price of a product changes in response to changes in the market conditions. For instance, when demand increases relative to a fixed supply, prices are expected to adjust flexibly upward and when demand decreases, the direction of price change is downward, all things being equal. Essentially, this prediction forms part of the fundamental principles of hotel revenue management and it is expected that as occupancy rate rises, the probability of an upward adjustment in room rates should also increase. Equivalently, this implies that as occupancy increases the probability of a downward adjustment in room rate becomes less likely.

Reviewing the findings of this study against these theoretical predictions of RM, it is clear that the evidence supports these predictions. Occupancy rate positively influences the probability of an aggregate increase in room rate and at the same time it decreases the probability of an aggregate decrease. To this end, it can be asserted that hotels in Hong Kong, particularly the sampled hotels, are practising revenue management correctly. In a previous study on dynamic pricing strategies, Abrate et al. (2012) made reference to the proportion of hotels in their sample with available room, in lieu of occupancy rate which was not available to them, to infer that price increases with demand.

Regarding size of hotel, the findings did not conform to a priori expectation. As would have been expected, medium- and large-sized hotel, in comparison to small-sized hotels, were envisaged to be more likely to have an aggregate decrease in their room rate due to the large inventory they have to sell. However, the evidence to the contrary was established: being medium- or large-sized hotel contributed positively to the probability of an aggregate increase in room rate and negatively to the probability of an aggregate decrease, especially on Tuesdays. As a plausible justification, the generally high occupancy rates in Hong Kong was used to rationalize these findings. In doing so, the argument put forward was that because occupancy is high in Hong Kong, small-sized hotels were likely to sell out their double/twin rooms creating a spill-over effect of demand to the medium- and large-sized hotels which could increase the probability of an aggregate increase in room rate for these group of hotels with room availability.

In addition to the aforementioned factors, the spatial location of hotels also influenced the probability of an aggregate increase/decrease in room rate due to possible differences in the targeted customers relating to specific locations and/or the relative attractiveness and accessibility of the locations. As expected, hotels located in districts other than the central business district, where usually demand and competition are high (Egan & Nield, 2000), were less likely to have an aggregate increase in room rate and more likely to have an aggregate decrease. Distance to the airport and proximity to the train station were similarly significant in determining the probability of the aggregate direction of room rate change. The effects of these variables seemed to suggest that being distant from these transport systems was contributing positively to the probability of an aggregate increase in room rate.

The findings discussed in this section have several practical implications. First, the observation of an aggregate increase or decrease in room rate implies that in as much as customers booking hotel rooms risk a higher chance of paying a higher price, there are still some possibilities that they could make some saving on last-minute booking. The practical implication of this is that dynamic pricing may not only be beneficial to hotels that are implementing it but also to some hotel guests/customers. Second, the evidence on the relationship between spatial locations and probability of either an aggregate increase in room rate or an aggregate decrease can be used for consumer purchase decision and hotel developers' site selection.

Finally, the positive influence of size on the probability of an aggregate increase in room rate suggests that, in the particular case of Hong Kong, operating medium- and large-sized hotels does not necessarily lead to the supposed risk of empty rooms which may prompt downward adjustments in room rate since demand is generally high in this market. To the contrary, the medium- and large-sized hotels seem to benefit by way of spill-over demand from small-sized hotels which result in aggregate increases in their room rate. Thus, for hotel developers in Hong Kong, building medium to large size hotels may be a superior option for the effective practice of revenue management.

4.6 Empirical results of dynamic price dispersion

Consistent with the format for presenting earlier findings (Sections 4.4 and 4.5), this section starts with a description of dynamic price dispersion, followed by the regression results and concluded with a discussion of the findings.

4.6.1 Descriptive results

Recognizing that hotels dynamically adjust their room rate toward a target date of check-in, it is not clear how large or small these adjustments could be. The goal of this section is to provide summary statistics that can shed light on the magnitude of dynamic price adjustments in general and to demonstrate how the magnitude differs according to mid-weekday (Tuesday) or weekend (Saturday).

As explained in the literature review, several measures/indices of dispersion could be used to achieve the current goal. The common ones include price range (Brynjolfsson & Smith, 2000), price index (Pratt et al., 1979; Schwieterman, 1985), price gap (Baye et al., 2004), standard deviation (Dahlby & West, 1986), coefficient of variation (Alderighi, 2010; Giaume & Guillou, 2004; Sorensen, 2000), and Gini coefficient (Borenstein & Rose, 1994; Gerardi & Shapiro, 2007; Obermeyer et al., 2013). Others include Atkinson and Entropy indices (Hayes & Ross, 1998; Obermeyer et al., 2013), and the Power Divergence statistic (Mantin & Koo, 2009).

In the context of airfares, the Gini coefficient and coefficient of variation (CV) are the commonly used price dispersion measures (Alderighi, 2010). However, in this study, the CV is mainly adopted for its appropriateness to the goal under investigation. That is, unlike the airfare studies, where dispersion is measured among flights on a particular route, the dispersion in this study is measured dynamically with reference to the same room type for a specific target date over time. Therefore, the use of CV is appropriate because it expresses the standard deviation as fraction of the mean and allows for the controlling of the average room rate in each period for each target date. Describing the dynamic price dispersion of hotels in European cities, Abrate et al. (2012) also found the CV to be most appropriate.

In addition to the CV, the alternative measures of range, standardized range and price index as reported in other studies (Brynjolfsson & Smith, 2000; Pratt et al., 1979; Schwieterman, 1985) have also been given brief consideration to provide a fuller picture of the size of the dynamic price dispersion and to complement the robustness checks of the regression analysis performed with these alternative measures. Accordingly, the summary statistics of the CV, range, price ratio and standardized range are reported in Table 4.7.

Table 4. 7: Summary statistics of measure of dynamic price dispersion

Measure of dispersion	**Summary statistic**	**Saturday**	**Tuesday**	**Overall**
Coefficient of variation (CV)	Mean	0.1170	0.0945	0.1057
	Standard deviation	0.0887	0.0801	0.0853
	Minimum	0.0000	0.0000	0.0000
	Maximum	0.6819	0.6921	0.6921
Range of room rate	Mean	502.21	336.12	419.17
	Standard deviation	459.90	366.58	424.05
	Minimum	0.0000	0.0000	0.0000
	Maximum	3613.0	3660.0	3660.0
Price ratio (highest over lowest)	Mean	1.3787	1.2931	1.3359
	Standard deviation	0.3341	0.2860	0.3139
	Minimum	1.0000	1.0000	1.0000
	Maximum	3.8619	2.9169	3.8619
Standardize range (as a fraction of mean)	Mean	0.3041	0.2420	0.2731
	Standard deviation	0.2323	0.2077	0.2225
	Minimum	0.0000	0.0000	0.0000
	Maximum	1.5372	1.4298	1.5372

As reported in Table 4.4, the mean coefficient of variation across all hotels for the entire period of the data collection is 11%, with a maximum variation of about

69%. This means that, within the seven days prior to checking in a hotel in Hong Kong, room rates can deviate from the mean price by almost 11% of the average price for the seven days. In some case(s), the deviation about the mean could be as high as 69%. Examining the dispersion in terms of the mid-weekday and weekend, the extent of dispersion on Tuesdays (9.4%) was found to be averagely lower than that on Saturdays (11.7%).This finding goes to confirm the earlier point made about price stability (in Section 4.5.1) that even though room rates were generally unstable, they were relatively more stable on Tuesdays than on Saturdays.

Consistent with the CV, the alternative measures of dispersion represented by range, standardized range and price index also show higher price dispersion on Saturdays than on Tuesdays. On Saturdays, the mean values of the range, standardized range and price index were 502.21, 0.30 and 1.38 respectively as against the corresponding values of 336.12, 0.24 and 1.29 respectively on Tuesdays. These results are comparable to the findings of Abrate et al. (2012) in two significant respects.

First, they confirm that dynamic price dispersion is prevalent in Hong Kong as it is in the eight major European cities that were investigated by Abrate et al. (2012). Second, the consistency in findings demonstrates that dynamic price dispersion for weekday customers is lower than the equivalent on weekend. By imputation this can logically be translated into an inverse relationship between size of dispersion and customers' sensitivity to price change. For the days that are believed to be dominated by price sensitive customers, such as Saturdays, the magnitude of dynamic price dispersion is higher; while on days that are believed to be dominated by less-price-sensitive customers, the extent of dynamic price dispersion is lower.

4.6.2 Econometric results

From the findings in the previous section and existing literature (Abrate et al., 2012; Ropero, 2011), it is known that dynamic price dispersion is mainly caused by inter-temporal variation in room rates. However, what remains unknown is the factor(s) that influence the size or magnitude of dynamic price dispersion. The objective of the analysis in this section is to identify such factors using spatial econometric analysis. The spatial model(s) was used because the degree of price dispersion by one hotel was conceivably thought to be influenced by the degree of price dispersion by its neighbours.

Tables 4.8 and 4.9 report the results of the Spatial Durbin Model (SDM) for dynamic price dispersion on Saturdays and Tuesdays respectively. The SDM was selected as the best model to report after statistical comparisons of the results with other spatial models like the spatial autoregressive mode (SAR), spatial error model (SEM) and ordinary least squares which does not assume spatial dependence (See Tables A12 and A13 for the statistical comparison of the results).

Table 4. 8: Spatial Durbin Model regression results for Saturdays

Variables	*Main*	*Lag*	*Direct*	*Indirect*	*Total*
ln(demand)	0.237***	-0.0286	0.238***	0.142	0.380***
	(3.55)	(-0.28)	(4.25)	(1.08)	(6.28)
Seller density	-0.00017**	0.0129	-0.00009**	0.0132	0.0133
	(-2.17)	(0.97)	(-2.09)	(1.05)	(1.02)
Ln(starting price)	-0.0439***	0.00114	-0.0433***	-0.0318	-0.0751***
	(-2.98)	(0.04)	(-2.75)	(-1.30)	(2.74)
Ln(size)	-0.0128***	0.0330	-0.0122***	0.0184	0.00614
	(-2.98)	(0.55)	(-2.35)	(0.30)	(0.10)
Frequency	0.0758***	-0.135***	0.0748***	-0.0752***	-0.00035
	(10.34)	(-5.91)	(10.66)	(-3.66)	(-0.02)
Chain	0.00642	0.121**	0.0091	0.121**	0.130**
	(1.04)	(1.97)	(1.34)	(2.08)	(2.08)
4-star	0.0177**	0.134	0.0208**	0.136	0.157
	(2.27)	(1.46)	(2.48)	(1.43)	(1.58)
5-star	0.0340**	0.125	0.0363**	0.139	0.176
	(2.48)	(0.59)	(2.31)	(0.66)	(0.80)
Midscale	0.0477***	0.0406	0.0495***	0.0992	0.149
	(5.05)	(0.18)	(4.10)	(0.45)	(0.64)
Upper midscale	0.0453***	-0.129	0.0430***	-0.0690	-0.0260
	(4.23)	(-0.66)	(3.50)	(-0.36)	(-0.13)
Upper upscale	0.0226*	-0.0162	0.0215	0.0192	0.0407
	(1.71)	(-0.08)	(1.51)	(0.10)	(0.21)
Upscale	0.0278***	-0.235	0.0242**	-0.178	-0.154
	(2.64)	(-1.10)	(2.11)	(-0.97)	(-0.81)
Eastern & Southern	-0.0123	0.120	-0.0106	0.0886	0.0780
	(-0.38)	(0.29)	(-0.39)	(0.22)	(0.20)
New Territories	0.0301	0.688	0.0368	0.540	0.577
	(0.77)	(0.81)	(1.29)	(0.66)	(0.70)
Other Kowloon	-0.00098	-1.214**	-0.0207	-1.158**	-1.178**
	(-0.03)	(-2.52)	(-0.77)	(-2.51)	(-2.54)
Tsim Sha Tsui	0.0461	-0.195	0.0433*	-0.139	-0.0957
	(1.61)	(-0.70)	(1.85)	(-0.60)	(-0.43)
Wan Chai	0.00799	-0.0686	0.0053	-0.0556	-0.0502
	(0.29)	(-0.27)	(0.23)	(-0.26)	(-0.25)
Yau Ma Tei & Mong	0.0242	0.959	0.0233	0.119	0.142
Kok	(0.71)	(0.45)	(0.84)	(0.70)	(0.94)
Distance to Airport	-0.00074	0.0150	-0.00047	0.00987	0.0094
	(-0.42)	(0.36)	(-0.30)	(0.25)	(0.24)
Distance to nearest	-0.0265	-0.110	-0.00416	-0.167	-0.171
train station	(-0.38)	(-0.56)	(-0.62)	(-0.86)	(-0.88)
Mean distance to top	-0.00271	-0.0981	-0.00369	-0.0703	-0.0740
attractions	(-1.48)	(-0.89)	(-1.43)	(-0.65)	(-0.68)
Constant	-2.108***				
	(-3.22)				
Rho		0.725***	R-squared	Within	0.0841
		(11.80)		Between	0.6310
Variance lgt_theta		0.593***		Overall	0.1834
		(2.95)	N		3267
Sigma_e		0.0059***	Log-pseudolikelihood		3700.5311
		(14.81)			

Notes: t-statistics in parenthesis; standard errors are robust – adjusted for 126 clusters in hotels; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table 4. 9: Spatial Durbin Model regression results for Tuesdays

Variables	*Main*	*Lag*	*Direct*	*Indirect*	*Total*
ln(demand)	0.187***	-0.141***	0.186***	-0.00189	0.185***
	(7.01)	(-3.54)	(8.34)	(-0.06)	(7.32)
Seller density	-0.0083***	0.0243**	-0.0004*	0.0232	0.0228*
	(-2.91)	(1.98)	(-1.84)	(1.52)	(1.81)
Ln(starting price)	-0.0187***	0.0192	-0.0181**	0.00449	-0.0136
	(-2.71)	(1.08)	(-2.36)	(0.25)	(-0.71)
Ln(size)	-0.0122***	0.0767	-0.011**	0.0602	0.0491
	(-3.5)	(1.39)	(-2.49)	(1.04)	(0.80)
Frequency	0.0688***	-0.0838***	0.0684***	-0.0320*	0.0364**
	(11.84)	(-4.60)	(12.29)	(-1.82)	(2.04)
Chain	0.00114	-0.0463	0.00148	-0.0420	-0.0406
	(0.19)	(-0.61)	(0.22)	(-0.57)	(-0.52)
4-star	0.0153**	0.118	0.0184**	0.124	0.142
	(2.29)	(1.39)	(2.47)	(1.34)	(1.46)
5-star	0.0141	0.106	0.0162	0.115	0.131
	(1.09)	(0.46)	(0.99)	(0.48)	(0.52)
Midscale	0.0311***	0.0130	0.0323***	0.0615	0.0937
	(3.32)	(0.05)	(2.61)	(0.27)	(0.40)
Upper midscale	0.0269***	0.0436	0.0270**	0.0826	0.110
	(2.62)	(0.18)	(2.08)	(0.37)	(0.47)
Upper upscale	0.00613	-0.0592	0.0047	-0.0323	-0.0276
	(0.53)	(-0.29)	(0.35)	(-0.16)	(-0.13)
Upscale	0.0212**	0.0669	0.0218*	0.107	0.129
	(2.09)	(0.25)	(1.85)	(0.47)	(0.55)
Eastern & Southern	-0.0234	-0.00623	-0.0243	-0.0250	-0.0493
	(-0.87)	(-0.02)	(-1.05)	(-0.10)	(-0.21)
New Territories	-0.0135	0.264	-0.0132	0.132	0.119
	(-0.40)	(0.42)	(-0.53)	(0.20)	(0.18)
Other Kowloon	-0.0204	-0.711	-0.0332	-0.657	-0.691
	(-0.76)	(-1.58)	(-1.46)	(-1.48)	(-1.55)
Tsim Sha Tsui	0.00327	-0.123	0.00044	-0.0912	-0.0908
	(0.14)	(-0.49)	(0.02)	(-0.41)	(-0.43)
Wan Chai	-0.0142	-0.0582	-0.0165	-0.0502	-0.0667
	(-0.61)	(-0.27)	(-0.83)	(-0.27)	(-0.38)
Yau Ma Tei & Mong	0.00978	0.0308	0.0075	0.0551	0.0626
Kok	(0.33)	(0.16)	(0.27)	(0.36)	(0.45)
Distance to Airport	-0.00268**	0.0215	-0.0024**	0.0146	0.0122
	(-2.21)	(0.99)	(-2.27)	(0.76)	(0.63)
Distance to nearest	-0.00406	-0.0138	-0.00435	-0.0712	-0.0756
train station	(-0.85)	(-0.07)	(-0.92)	(-0.33)	(-0.34)
Mean distance to top	-0.0046***	0.0307	-0.00382*	0.0505	0.0466
attractions	(-3.59)	(0.32)	(-1.80)	(0.51)	(0.46)
Constant	-1.672***				
	(-6.06)				
Rho		0.732***	R-squared	Within	0.1248
		(11.39)		Between	0.5510
Variance lgt_theta		0.513***		Overall	0.1909
		(2.80)	N		3267
Sigma_e		0.00474***	Log-pseudolikelihood		4044.6209
		(14.90)			

Notes: t-statistics in parenthesis; standard errors are robust – adjusted for 126 clusters in hotels; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; luxury hotels is reference group for class and Central & Western is the comparison group for district.

The interpretation of the parameters in SDM are not straightforward (Elhorst, 2010) but the results are much richer than the conventional spatial analysis (Yang, Noah & Shoff, 2015). This is due to the fact that the model captures feedback effects among the explanatory variables of neighbouring units (LeSage & Pace, 2010). As LeSage and Pace (2010, p.369) reckon, "[a] change in the characteristics of neighbouring regions can set in motion changes in the dependent variable that will impact the dependent variable in neighbouring regions". Thus, the effect of an explanatory variable may consist of a direct effect from the focal unit and the indirect effects (spill-over effects) from the neighbouring units.

With these explanations in mind, the interpretation here will focus on the direct and indirect effects. The direct effects are those effects originating from the focal hotel while the indirect effect emanates from the neighbouring units. A point that should be noted is that the direct and indirect effects can have the same sign (positive or negative) or different signs (one positive and the other negative). In either cases, positive indirect effects are interpreted as spill-over while negative indirect effect are regarded as the outcome of a relativity process – i.e. negative feedback (Yang et al., 2015).

Referring to the results in Tables 4.8 and 4.9, one finding that is worth emphasizing is the coefficient of *rho*. This shows that price dispersion of one hotel can be explained by neighbouring hotels' price dispersion. Notably, the statistical significance and positive coefficient of this variable signifies spill-over effect for the dependent variable. Thus, it can be inferred that controlling for other explanatory variables, higher dispersion in the price of neighbouring hotels will increase the price dispersion of any focal hotel.

Starting with the results for Saturday (Table 4.8), one can observe that the variables with direct significant positive effects on dynamic price dispersion are demand, frequency of price change, star rating and class of hotel. Conversely, the variables that have direct significant negative effects on dynamic price dispersion are starting price and size. In terms of indirect effects, there are only two statistically significant variables: frequency and chain. While the indirect effect of frequency switches to negative (compared to direct effect), chain affiliation has a positive indirect effect on the size of dynamic price dispersion.

Regarding the relationship between price dispersion and frequency of price change, the results demonstrate that as a hotel changes its room rate more frequently, the size of its price change tends to be larger. However, the more frequent its neighbouring hotels vary their prices, the smaller the size of its price dispersion. The negative indirect effect suggests that, although hotels react to the frequency of price change of its neighbours, the reaction lowers the magnitude of its price dispersion.

The effect of another variable that is worth noting is the initial price. As indicated in the methodology, this variable was introduced to control for the load factor from one week to another. The statistically negative direct effect of this variable shows that for weeks that the starting price is high (presumably because of high demand), the size of dynamic price dispersion for the week in question tends to be lower. This finding may be attributed to the fact that, at high starting price, it is almost unlikely to observe greater variability in price because a hotel might have closed all their lower BAR rates, restricting them to just the highest BAR rate, hence the low variability in the rate.

Moving on to the results for Tuesdays (Table 4.9), the variables with positive direct effect on the magnitude of dynamic price dispersion are demand, frequency, star rating, and class. Similar to the Saturday results, there are three variables with negative direct effect on dynamic price dispersion in the Tuesday results. These are seller density, starting price and size. However, unlike the Saturday results, there is no variable with statistically significant positive indirect effect in the Tuesday results. The only statistically significant variable in this case (i.e. Tuesday) is frequency, which has a negative indirect effect.

Comparing the results of Saturday (Table 4.8) and Tuesday (Table 4.9), it can be noted that the results are largely consistent with each other in terms of signs of the significant coefficients (i.e. qualitatively). However, the differences lie in the set of significant variables for each model. For example, distance to the airport does not have direct effect on dynamic price dispersion on Saturdays, but it has significant negative influence on Tuesdays. Also, the difference between 5-star hotels' dynamic price dispersion and 3-star hotels' is not significant on Tuesdays but, on Saturdays, the difference is significant. Additionally, the indirect effect of chain affiliation on Saturday is not applicable on Tuesdays. The imputation from these differences is that, besides the individual factors identified, the magnitude of dynamic price dispersion can be said to be related to the booking day and by extension the type of customer. In the discussion that follows, some of these differences will be further highlighted as the effects of market structure variables, hotel characteristics and location-related attributes on dynamic price are closely examined.

4.6.2.1 Effects of market structure variables

In Industrial Organisation (IO) literature, a variety of explanations are offered to justify why price dispersion may exist and persist, and to identify the factors contributing to the size of dispersion. Some of the studies have suggested that dispersion arises out of price discrimination (Borenstein & Rose, 1994), while others have suggested that price dispersion is generated due to differences in search cost by consumers (Salop & Stiglitz, 1977). Yet another group of studies have suggested information-clearinghouse models to show that search cost may not be a necessary precondition for price dispersion (Baye et al., 2006). While these theories are not necessarily inconsistent, their predictions regarding the association between number of sellers and price dispersion can diverge – some predicting a positive relationship (Anderson & De Palma, 2005; Carlson & McAfee, 1983), and others a negative relationship (Perloff & Salop, 1985).

Related to capacity-constrained firms such as hotels, Prescott (1975) developed an equilibrium price dispersion model for homogeneous goods which was applicable to a perfectly competitive market. This model was further developed by Eden (1990) and extended by Dana (1999) to monopoly and imperfect competition. Dana (1999) has shown that there exists a unique pure strategy equilibrium in price distributions with intra-firm price dispersion in which each firm offers its output at multiple prices. Consistent with Prescott's model, Dana reaches the conclusion that as competition increases, the average price falls but the degree of price dispersion increases.

Similar to previous studies (Balaguer & Pernías, 2013; Barron et al., 2004) the empirical verification of Dana's prediction was conducted in this study by including the number of sellers in a localized market (i.e. seller density) in the regression analysis. As shown in Tables 4.7 and 4.8., the estimated coefficients of the density indicate a negative direct effect on dynamic price dispersion, meaning that the higher the number of localized competitors (i.e. increasing competition), the lower the degree of dynamic price dispersion. This result is consistent for both the Saturday and Tuesday regression estimates, emphasizing the importance of competition in the pricing behaviour of hotels.

The other market structure-related variable which was included in the models to capture the overall market condition was demand. The coefficient of this variable also proved to be significant in both the Saturday and Tuesday regressions. However, different from the effect of seller density, the direct effect of demand on dynamic price dispersion was positive, indicating that as demand increases, it increase the size of dynamic price dispersion all other things being equal.

4.6.2.2 Effects of hotel characteristics

Across all industries, differentiation has been widely recognized as an effective strategy to minimize competitive pricing pressures and to obtain superior performance (Porter, 1980). Within the same industry, customers might have different preferences toward similar but differentiated products. As such, firms offering differentiated products can leverage on the different customer preferences to act as monopolistic competitive firms and charge different prices (Chamberlin, 1933). As a broad conceptualization of differentiation, Dubé and Renaghan (2000) state that any feature of a firm that is relevant to some customers can be considered as a potential source of differentiation.

In the hotel industry, previous studies have identified a number of characteristics that can differentiate one hotel from another. Examining the differences in dynamic pricing dispersion in this study, four of such hotel characteristics commonly used in previous studies; namely, chain affiliation, star rating, size and class, were included in the models. Results from these variables demonstrate some significant relationships, either directly or indirectly. On both Saturdays and Tuesdays, the coefficient of *size* has a negative direct effect on dynamic price dispersion, indicating that the higher the number of rooms in a hotel the smaller the size of its dynamic price dispersion.

Mainly, the dummy variables for star rating, class of hotel and chain affiliation also have significant direct effect on dynamic price dispersion. Especially, the direct effects of the dummies for star rating were positive, showing that, compared to 3-star hotels, 4- and 5-star hotels have significantly higher price dispersion. Also compared to luxury hotels, midscale, upper midscale and upscale hotels have higher price dispersion. As a reflection of the ADR rankings, these results could be interpreted to mean that low-priced hotels have higher price dispersion, compared to high-price hotels. Relating this interpretation to the coefficient of starting price, it can be noted that a similar conclusion can be reached since the direct effect of starting price on dynamic price dispersion is also negative.

4.6.2.3 Effects of location attributes

In the IO literature, Carlson and McAfee (1983) and the pioneer of spatial competition, Hotelling (1929), have argued that spatially differentiated firms selling homogeneous products can have different price dispersion, reflecting customers' preferences and intensities of demand in different locations. As a complex service industry, pricing of hotel rooms may not just be related to location as a results of spatial agglomeration and competition but also hotel products are interconnected with tourism infrastructure, transport system and other public goods and services, which make these attributes a composite part of its price. Hedonic pricing analysis of hotel products have shown that these location-related attributes do influence the average price of hotel room (Rigall-I-Torrent & Fluvià, 2011).

As a sequel to the hedonic pricing, the effects of location attributes on the coefficient of dynamic price variation were tested in this study, using distance to the airport, distance to the nearest train station, mean distance to attractions and, above all, the administrative district within which hotels were located. Of these, the variables that had a significant direct effect on magnitude of price dispersion were distance to the airport and mean distance to top attractions.

4.6.3 Discussion

As indicated in the literature review, price dispersion studies have gained significant research attention in the last two to three decades, following the Internet revolution which has made it possible for pricing data to be obtained. The concentration of the studies however has been on the airline industry, with limited studies on the hotel industry. In most of the airline studies, dispersion has been measured among airlines running on the same route. Thus, making the focus of the airline studies to be inter-firm price dispersion.

In contrast to the price dispersion studies in the airline, this study has investigated intra-firm inter-temporal price dispersion with attributes of hotels, location characteristic and market conditions as the determining factors. The results have some similarities with those in the airline industry but also differ in some respects. A discussion of these consistencies and inconsistencies is the agenda for the subsequent paragraphs.

Analysing a random sample of 10% of U.S. domestic airline tickets, Borenstein and Rose (1994) found that considerable price dispersion exist in the fares charged to different passengers on the same route. Specifically, the authors found that for any two randomly chosen passengers on the same airline and route, the average expected price difference could be as much as 36%. The differences in the fares were observed to be related to ticket characteristics such as refundability, advance purchase discounts, Saturday night stays, and various travel and stay restrictions. Also, consistent with the models of monopolistic competition presented by Borenstein (1985) and Holmes (1989), the authors found that competitive routes exhibited more prices dispersion than the less competitive routes, but increased market density and high concentration of tourist traffic lowered price dispersion.

As far as the hotel industry is concerned, empirical literature addressing the association between dispersion and seller density is very limited. The closest study to this area is Balaguer and Pernías (2013). In their study, the authors were not concerned about dynamic price dispersion but the unaccounted-for variance in price which they referred to as price dispersion. Their findings demonstrated that this kind of dispersion was inversely related to seller density. The negative effect of seller density is consistent with the finding of Barron et al. (2004), who found that price dispersion for unleaded gasoline decrease with an increase in the number of sellers.

The positive effect of frequency on size of price change supports the theoretical prediction of Rotemberg (1982) that in the presence of convex cost of price adjustment, frequency and size correlates positively. Using micro-level data in Slovakia and making a distinction between firms with less frequent price changes and those with frequent price changes, Horváth (2011) found a mixed results. For more rigid prices, a negative correlation existed between frequency and size of price changes while for less rigid price, a positive correlation existed. Examining the price setting in a leading Swiss online supermarket, Berka et al. (2011) also found positive association between the frequency of a reference change and the absolute level of price change.

4.7 Summary of the chapter

This chapter has presented and discussed the findings of this study. The findings were organized into descriptive and econometric results. The descriptive analyses have shown that price adjustment was quite often with an average of 4 and a modal frequency of 5. The overall price pattern demonstrated a preponderance of aggregrate increases with an average dispersion of about 11%. The results of the econometric analyses have indicated a number of findings. First, the empirical results on the determinants of price fluctuations have shown that occupancy, and localized competition are the common factors that influence the frequency of room rate change on Saturdays and Tuesdays. In addition to these, size affects the frequency of room rate change on Saturdays but not on Tuesdays while star rating affects the frequency of room rate change on Tuesdays but not on Saturdays.

Second, the empirical results on price patterns have also revealed that the probability of an aggregate increase in room rates is influenced by occupancy rate, size of hotel, star rating, distance to the airport and distance to the nearest train station. These were also the influential factors on the probability of an aggregate decrease in room rate, albeit in reverse order of the signs. Lastly, the results from the SDM have indicated that the dynamic price dispersion of a hotel depends on several factors, including the dispersion in the price of its neighbours, demand, frequency of price change, size, star rating and class of hotel.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter concludes the study. The chapter begins with an overview of the study by summarizing all the previous chapters, including the current one. This is followed by a recap of the major findings and how they address the objectives of the study. In addition, the major contributions of the study to theory and practice are highlighted. Finally, the limitations of the study are identified and useful direction for future research are suggested.

5.1 Overview of the thesis

This study sought to analyse online price data for hotels in Hong Kong with the objectives to characterize their pricing behaviour in three respects – frequency of price change, pattern of price change and magnitude of dynamic price dispersion – and to identify the factors influencing these pricing behaviour. Accordingly, these goals were achieved through a scientific process of inquiry which has been organised into five logically-connected chapters.

Chapter one set out to introduce the study by presenting relevant background information on the evolution of Internet distribution channels and zeroing in on how these platforms have contributed to making pricing data transparent to both customers and hoteliers, thereby engendering keen interest in online pricing behaviour. The chapter further went on to identify the critical aspects of online pricing behaviour that have received either limited or no attention in the hospitality literature yet present greater potentials for advancing knowledge and practice of revenue management pricing and customer decision making. To this end, the main research gaps that were identified for this study were that even though the Internet is known to have enabled hotel operators to frequently adjust their room rates due to the implementation of dynamic pricing and revenue management, there are hardly any studies in the field that explain hotels' heterogeneity in the frequency of room rate change, pattern of price change and magnitude of dynamic price change (i.e. dispersion) resulting from the practice of dynamic pricing. In line with these research gaps, the overriding research questions were derived to determine the research objectives as follows:

1. Measure the frequency of price change online and analyse the factors influencing it in the Hong Kong hotel market;
2. Determine the patterns of price change online and examine the influencing factors in the Hong Kong hotel market; and
3. Quantify the size of dynamic price dispersion and identify the factors that determine its magnitude in the Hong Kong hotel market.

Additionally, the chapter provided the significance of the study to justify why it should be conducted. Lastly, the structure of the thesis was presented to help readers navigate through its content.

Chapter two was devoted to the literature review. This covered an expanse of theories and empirical studies that are relevant to the conceptualization and contextualization of the research agenda. Among others, the theories discussed included the structure conducted performance paradigm, hotel location models and spatial agglomeration theory. In brief, the SCP theory explains the conduct of firms, which includes pricing in terms of market structure, while the spatial agglomeration recognizes the interaction among firms that cluster within a geographical location. In addition to these theories, several cost-of-price-adjustment theories in the offline markets were reviewed as regards their application to the digital economy. The list of the theories includes the menu cost, managerial decision and customer cost. Stated briefly, these theories argue that the frequency of price change is inversely related to the cost of price adjustment.

As part of the empirical works that were reviewed, studies on the airline industry, where revenue management originated and transferred to the hotel industry, were given prominence for the following reasons: first, as the trailblazer in implementing RM and dynamic pricing and second, as the industry with the most abundant empirical studies bordering on the subject matter under investigation. The limited empirical studies in the hospitality literature were also given rightful and extensive coverage to provide the connection with the existing knowledge in the area. Particularly, the limited studies conducted in the European cities were adequately reviewed to demonstrate as far as possible their similarities and differences with the Hong Kong market which is in Asia.

Through the combined literature review (both theoretical and empirical), a conceptual framework was developed to explain the three aspects of online pricing behaviour – frequency of price change, pattern of price change and size of dynamic price dispersion – and to identify the possible factors that could influence these behavioural patterns. Basically, the advanced framework stipulated that online pricing behaviour as described by the three dimensions is spatially-dependent and influenced by market structure (represented by demand condition and seller density), and product attributes represented by hotel characteristics (as defined by number of rooms, star rating, class and chain affiliation) as well as location accessibility and attractiveness attributes (which are defined by distance to the international airport, distance to the nearest train station, distance to top tourist attractions and district).

Chapter three covered the methodological issues explaining the research design in detail. In more specific terms, all the relevant issues of an effective research design regarding the fit between the topic and the methodology, population and sampling, data collection (including pilot testing), data management and preparation, data analysis and interpretation and, finally, reporting of results were discussed. Essentially, the research was designed as a quantitative study using descriptive and causal methods. Data were collected from multiple sources, including an Internet distribution channel which offers price comparison (i.e. Kayak.com), Smith Travel Research (STR), the Hong Kong Tourism Board's (HKTB) publications, and Google map. The process of the data collection on Kayak.com website was automated through a data-gathering agent which was specially developed for the purpose of this study. The data collection was done daily and lasted for a consecutive period of six months, from May 2014 to October 2014. In the end, the data preparation yielded 6552 observations for analysis, comprising 26 Saturday data points and 26 Tuesday data points for 126 hotels.

The core of the chapter was also devoted to explaining the econometric models adopted to address the three research objectives. Based on the distinctive properties of the data, three sets of separate models using panel data estimation techniques were described in this regard: Poisson and Negative Binomial count data – aimed to address research objective one; Logit and Probit models – targeted at addressing research objective two; and spatial models (including Spatial Autoregressive, Spatial Error model and Spatial Durbin model) – geared toward the attainment of research objective three. The conditions for evaluating the appropriateness of the modelling techniques and models' accuracy were also spelt out.

Chapter four presented the findings and discussion on each of the three objectives of the study. Regarding the first objective, the findings showed that the modal frequency of room rate change within the repeated 7-day window was 5 and the average was about 4. Occupancy rate, seller density, star rating, size and distance to the nearest train station were the significant determinants of the frequency of room rate change. Except the variable for 5-star hotel, which had a significant negative effect on the frequency of room rate change, the effects of all the other variables were positive. For the second objective of the study, the findings revealed that the pattern of price change was fluctuating (increase, decreasing and fixed). However, in terms of average direction of change, the dynamic adjustments resulting in aggregate increases were dominant for the entire sample and for each of the two days – Saturday and Tuesday. The intra-distribution analysis, however, showed that aggregate decreases in room rate were more prevalent on Tuesdays than on Saturday while the converse was valid for aggregate increases. In respect of objective three, the findings indicated that the mean coefficient of variation across all hotels for the entire period of the data collection was 11%, with a maximum variability of almost 69% about the mean price for the week. The identified factors influencing the size of the dynamic price dispersion were demand, size, starting price, frequency, star rating and class. In addition, the differences in the magnitude of dynamic price dispersion were also related to location attributes of hotels.

The current chapter which is the final chapter provides the conclusion and recommendations for future research and practice. In more specific details, the chapter provides an overview of the study which highlights the major issues discussed in all the chapters of this study. This is followed by a summary of the major findings and a brief discussion on how they achieve the objectives of the study. The significant contributions of the study to literature and practice are also highlighted. The last two sections of this chapter are devoted to explaining the limitations of the study and opportunities for further research that fall out of this study.

5.2 Summary of major findings and achievement of research objectives

This study was conducted to address three objectives. First, to measure the frequency of price change online and analyse the factors influencing it in the Hong Kong hotel market. Second, to determine the pattern of price change online and examine the influencing factors in Hong Kong hotel market. Finally, to quantify the size of dynamic price dispersion and identify the factors that determine its magnitude in the Hong Kong hotel market. To demonstrate how these objectives have been achieved, the major findings are summarized for each research goal.

5.2.1 Objective 1

To measure the frequency of price change online and analyse the factors influencing it in the Hong Kong hotel market

The descriptive analysis involving the percentage count of the frequency of room rate change revealed that, in Hong Kong hotel market, prices can be expected to change one to seven times in the seven-day period prior to check-in. The modal frequency of room rate change was five while the average was approximately four. These figures, suggest that room rate change in the Hong Kong hotel market is anything but stable. These results further confirm that dynamic pricing policy is implemented in the Hong

Kong market. The analysis of the frequency of room rate change on either the mid-weekday (Tuesday) or weekend (Saturday) revealed similar average and modal statistics, indicating price variation toward different customers was largely comparable.

However, the notable difference was that relative to Tuesdays' adjustments, most Saturdays' rates were associated with frequent adjustments. Similarly, with reference to less-frequent adjustments, most Tuesdays' rate were adjusted less frequently than Saturdays. Explaining these subtle differences, two interpretations were offered. One, the more frequent price changes on Saturdays were interpreted to mean that because Saturday customers are predominantly leisure customers, with higher price sensitivity, most hotels indulge in frequent price adjustment to sell their rooms. This interpretation suggests that competition to sell rooms is perhaps keener on Saturdays than on Tuesdays. Two, the more infrequent price changes on Tuesday was interpreted to mean that perhaps demand on weekday is more stable than on weekend given that business customers' buying decisions are usually planned ahead and not spontaneous.

The econometric analysis also identified that the frequency of room rate change was statistically influenced by a set of factors including occupancy, seller density, star rating, size, class, and distance to the nearest train station. The effects of occupancy, seller density and distance to the nearest train station on the frequency of room rate was positive and consistent across the two booking days (Saturdays and Tuesdays). However, the influence of star rating on the frequency of room rate change was only significant on Tuesdays. Precisely, the frequency of room rate change by the highest star-rated hotels (5 star) was lower than that of 3-star hotels. This means that, compared to 3-star hotels, 5 star hotels were engaged in less frequent price changes on Tuesdays.

The significance of hotel size on the frequency of room rate change was also realized only on Saturdays but not on Tuesdays. From the results, it emerged that relative to small-sized hotels (hotels with less than 100 rooms), medium-sized (between 101 and 300 rooms) and large-sized (more than 300) hotels were more likely to have higher frequency of room rate change.

5.2.2 Objective 2

To determine the pattern of price change online and examine the influencing factors in Hong Kong hotel market

The results of the pattern of price change as demonstrated in the data showed no consistent direction of room rate change within the booking period. Rather, it was observed that prices could increase, decrease or remain unchanged (i.e. fluctuating). Determining the average direction of change, it was observed that changes in the room rates resulting in aggregate increase was about 60.64 percent while in the rest of the cases, aggregate decreases and no-change accounted for 33.04 percent and 6.32 percent respectively.

For the Saturday and Tuesday results, similar patterns as shown in the overall data were discovered. However, it was also noted that room rate changes resulting in aggregate increase were predominant on Tuesdays while those resulting in an aggregrate decrease were dominated by price adjustments on Saturdays. These intra-distribution differences highlighted the prospects of paying less or more when booking a room for a single night stay on either a Saturday or a Tuesday. Thus, it was suggested that the prospect of saving money on last minute booking was relatively higher on

Tuesday than on Saturday. Conversely, the prospect of paying a higher price on last-minute booking was higher on Saturday than on Tuesday.

The estimation of the effects of market structure variables, hotel characteristics and location attributes on the probability of aggregate increase in room rate or aggregrate decrease also revealed some interesting results. Generally, occupancy, star rating, size, class, location, distances to the airport and nearest train station were identified as the significant variables that influence the probability of an aggregate increase or an aggregate decrease in room rate. As would be expected the coefficient of these variables bore the opposite signs in the aggregate decrease model as in the aggregate increase, confirming that a variable could not be contributing to the probability of an aggregate increase and aggregate decrease in the same fashion.

Apart from this important difference, there were factors that contributed to the probability of either an aggregate increase or aggregate decrease but not both, especially with regard to Tuesdays. For example, being a 5-star hotel lowered the probability of an aggregate increase in room rates on Tuesday but did not have a significant influence on the probability of an aggregate decrease. This finding suggests that perhaps the room rates of the highest-star-rated hotels were sticky down as espoused by the quality signalling theory but flexible upward.

Other interesting findings that have been derived from the regression results are that the probability of an aggregate increase or an aggregate decrease in room rate on either Saturday or Tuesday are uniquely influenced by some factors. For the aggregate increase in room rate on Saturdays, the distinctive factors are the class of a hotel and distance to the nearest train while for an aggregate increase in room rate on Tuesdays, the unique factor is star rating. With regards to the probability of an aggregate decrease in room rate, size of hotel is the additional significant variable for the Tuesday regression. However, for the aggregate decrease in room rate on Saturday, the distinctive significant variable is distance to the nearest train station.

5.2.3 Objective 3

To quantify and analyse the factors that influence the size of dynamic price dispersion

The descriptive analysis reveals that the extent of dynamic price dispersion ranged between 0 and 0.69 with an average of 0.11. These values show that, on the average, room rates could deviate from their mean by (+/-) 11% of the average room rate for the week. In some cases, the deviation could be as high as 69%, demonstrating that the extent of dynamic price could be high. The dispersion on the mid-weekday and weekend is different. The extent of dynamic dispersion on Saturday is about 12% while that on the Tuesday is 9.4%. This difference sort of indicated that pricing on Tuesday is relatively less dynamically unstable than on Saturday. This was consistent with the descriptive results on the pattern of price change revealed under objective 2.

The significant variables with direct positive effects on dynamic price dispersion are demand, frequency of price change, star rating and class of hotel. The effects of these variables are qualitatively similar on either Saturday or Tuesday. To the contrary, the variables that have direct significant negative effects on dynamic price dispersion are starting price and size. The effects of these are also similar on either of the days. The notable differences, however, are mainly in terms of the indirect effects. For the Saturday results, demand, frequency and chain affiliation have indirect effect while, for Tuesday, only frequency is the variable with indirect effect.

Considering the differences in the results for Saturdays and Tuesdays, it is inferred that the magnitude of dynamic price dispersion could be related to the type of customer since some of the factor(s) affected dispersion on either days but not both. For example, while distance to the airport had a direct positive effect on dynamic price dispersion on Tuesdays, its effect on dispersion on Saturday was not significant. Similarly, the extent of dispersion between 3-star hotels and 5-star hotels was only significant on Tuesday.

5.3 Major contributions of the study

The major contributions of this study are highlighted and discussed in two ways. First, the contributions to knowledge and literature are discussed. This is then followed by a discussion on how the findings can contribute to practice in the industry, highlighting the significance to hotel practitioners and customers.

5.3.1 Contributions to knowledge and literature

As the foremost contribution to knowledge, this study has advanced the understanding on online pricing behaviour by offering quantitative results to answer the following questions which have eluded past researchers: how frequent do hotels dynamically adjust their price? What is the average direction of the price adjustment? How large are dynamic price adjustment? The answers to these questions, although limited to the 7-days prior to check-in, demonstrate in no-less important way the extent to which dynamic pricing is being practiced in the Hong Kong hotel market as a whole as well as the heterogeneity in the practices by different hotels towards different customers booking on different days. With the introduction of mobile applications and technologies, last-minute booking has become a common practice, hence the focus on the 7-days prior to check-in is even more important.

Second, the study has offered a comprehensive framework drawn mainly from the industrial organisation literature and augmented with relevant hotel-industry-specific literature to identify the factors that can be combined with demand-based pricing policy to explain the heterogeneous pricing behaviour of hotels. Precisely, the advanced framework states that online pricing behaviour, as represented by frequency of price change, pattern of price change and magnitude of dynamic price dispersion, is explained by market structure variables (including demand and seller density), hotel characteristics (including chain affiliation, star rating, number of rooms and class), and location attributes (including distance to the international airport, distance to the nearest train station, distance to the top tourist attractions and administrative district).

Third, the study has extended the literature on price dispersion from inter-firm dispersion to intra-firm dispersion, where dispersion has been analysed with respect to the same room type over time. Thus, different from previous studies, this study has not only described the extent to which prices can be dispersed through dynamic pricing policies, as done in a previous study by Abrate et al. (2012), but also has identified factors that can be used in addition to revenue management pricing to explain the heterogeneity in the magnitude of the dispersion. The value in this contribution is that it has demonstrated that although all hotels are free to vary their prices, the frequency of room rate change is not uniform across the spectrum of hotels.

Fourth, the study has offered empirical evidence to add to the dearth of existing literature on pricing studies in the hotel industry, particularly the frequency of price change. Prominently, the findings have contributed empirical evidence to identify location-related attributes specific to the hotel industry that influence the frequency of room rate change. Contrasting this to prior studies on the frequency of price change, this is the first attempt to formally include location attributes to explain the frequency of price change in the hotel context. Understandably, prior studies on the frequency of price change in other industries have not made such attempt because the attribute of non-transferability did not apply to the products that were studied. However, for hotel products, this is necessary because hotel products must be consumed at the location of production and therefore it made logical sense to imagine that the frequency of price change could also be related to locational factors. In the large context of price adjustment theories, this study has added a new finding that product attributes can also influence the frequency of price adjustment.

Finally, the study has also made some methodological contributions in terms of application by adopting rigorous econometric techniques to ascertain the findings. Although the use of spatial models in the accommodation sector in general is not new in the literature, the application of these techniques to model price dispersion behaviour in the hotel industry, whose products are spatially-dependent, is done for the first time in this study.

5.3.2 Implications for industry

The main implications of this study have to do with the practice of revenue management in the hotel industry. However, certain implications can also be deduced for customers. The discussions in this section start with the implications for hotel practitioners and proceeds to the implications for customers.

5.3.2.1 Hotel practitioners

There are several implications of the findings of this study to hotel practitioners. The first is that, the findings on the frequency of room rate change has demonstrated that, although most hotels in Hong Kong frequently adjusted their room rates dynamically, the frequency of the temporal adjustments is independent of the administrative district in which hotels operate. This implies that as far as districts are concerned, hotel practitioners may not have to hold any reservations about how frequent they can actually change their price. The significant factors for them to take into account are the number of hotels in their immediate environment and the overall market demand.

The second implication for hotel practitioners is that since room rates were found to change frequently as a result of dynamic pricing policies implemented by all the hotels, it can be inferred that customers may not be able to identify hotels that are selling at the lowest or highest price by simply making reference to their past or previous experience. The indirect consequence of the frequent price adjustment is that the rankings of hotels in terms of average price keep moving up and down within the price distribution. Hence, hotel practitioners can continue to implement dynamic pricing strategy in accordance with demand conditions without fear of possible customer antagonization that may simply be triggered by dynamic pricing.

Third, the positive influence of size on the probability of an aggregate increase in room rate suggests that, in the particular case of Hong Kong, operating medium- and large-sized hotels does not necessarily lead to the supposed risk of empty rooms which, may prompt downward adjustments in room rate since demand is generally high in this market. On the contrary, the medium- and large-sized hotels seem to benefit by way of spill-over demand from small-sized hotels, which result in aggregate increases in their room rate. Thus, for hotel developers in Hong Kong, building medium to large size hotels may be a superior option for the effective practice of revenue management. Related to this, hotel developers can also use the results on the probability of an aggregate increase in room rate or aggregate decrease in room rate as manifested in different spatial locations to guide their decisions on location selection.

Fourth, the findings have also demonstrated that the frequency of price change and size of dynamic price dispersion depend on seller density and the pricing behaviour of neighbouring hotels among other factors. By implication, these findings suggest that in order to stay competitive, hotel practitioners need to take into account the structure of their localized market and the neighbouring hotels' frequency and size of price adjustments. Thus, even though the practice of dynamic pricing needs to be based on the recommendations of RM software, if any, it is equally important to combine such recommendations with the intelligence gathered on the pricing behaviour of neighbouring hotels so as to stay competitive.

Last but not least, the effect of seller density on the various aspect of pricing behaviour can be used by hotel practitioners to determine how the entry of a new competitor in the neighbourhood will affect the frequency of price change and the magnitude of dynamic price dispersion, assuming other factors remain unchanged. To this end, the results suggest that room rates can be expected to change more frequently as the number of competitors increases, but less so in terms of the magnitude of price changes.

5.3.2.2 Customers

To hotel customers, the identified relationships between the frequency of room rate change and hotel characteristics such as size and star rating can be used to determine the relative propinquity of having to pay higher or lower when booking a hotel belonging to a particular star category or size group. Especially, for customers who might wish to minimize the risk of having to pay higher for a room, this information can serve as a useful guide to their strategic decision-making. More importantly, the findings also revealed the differences in how frequent room rate changes on either a Saturday or Tuesday. This information can benefit leisure customers, who tend to stay on weekend and business guests alike, who usually make reservations for a weekday.

Furthermore, the observation of aggregate increases or decreases in room rate implies that, in as much as customers who are booking hotel room close to check-in date risk a higher chance of paying higher prices, there are still some possibilities that they could make some saving on last-minute booking. The practical implication of this is that dynamic pricing may not only be beneficial to hotels implementing it but also to some hotel guests/customers. In this sense, consumers can use the relationship between spatial locations and probability of either an aggregate increase in room rate or aggregate decrease to identify locations where it is most probable for dynamic pricing to result in price decreases.

5.4 Limitations and suggestions for future studies

In conclusion, this study has made some significant contributions to knowledge which can be used to improve RM practice. At the same time, it has also revealed a number of viable opportunities for future research through its inherent limitations. As the first delimitation, the study was conducted on Hong Kong hotels and therefore the findings may not necessarily reflect the practice of RM in other markets. This is especially so because the spatial structure of the hotels in Hong Kong was incorporated into the modelling. In this regard, future research efforts can extend this study to other markets or jurisdictions so as to determine any possible differences or similarities in the findings.

Secondly, the study relied on best available rates on the Internet, which can differ from actual transaction data or negotiated prices. To that extent, even though this study could not access actual transaction data due to confidentiality and privacy reasons, it will still be worthwhile if future research could explore the subject with data from different sources. Connected to this, the best available rate was collected for only one room type – i.e. the standard twin/double room. Rightfully, this type of room was chosen because it was the single most common room type to all the hotels in the target population. However, it can be recognized that the pricing behaviour of different room types may be different since their targeted consumers could differ as well.

Thirdly, it is envisaged that hotels may exhibit different pricing behaviour at different times in the booking period. However, because the focus of this study was on the seven days prior to check-in, these nuances could not be explored. As indicated earlier, the 7-day window was chosen because it is a period within which prices are expected to change regularly. Also, because of the development in technology especially mobile applications, last-minute booking is now a common practice. Nevertheless, future studies could extend the data collection period to supplement this current study.

Finally, the study was also limited to the two days in respect of which the data were collected. As in other studies (Abrate et al., 2012) these are the typical days that can represent week day pricing and weekend pricing. This said, the study can still be regarded as falling short of comprehensively addressing the potential day-to-day differences in pricing behaviour. Thus, future research can address this shortfall by analysing data in respect of all the seven days in a week.

5.5 Concluding remarks

To conclude, this final chapter has presented a summary of the current study and drawn conclusions about how the research objectives were achieved. In addition, the chapter has also identified the limitations of the study and made recommendations for future studies.

APPENDIX

Table A 1: Schedule for data collection

Month	Nights	Check-in	Check-out	Start of data collection	End of data collection
May	Saturday	3/5/2014	4/5/2014	26/4/2014	3/5/2014
	Tuesday	6/5/2014	7/5/2014	29/4/2014	6/5/2014
	Saturday	10/5/2014	11/5/2014	3/5/2014	10/5/2014
	Tuesday	13/5/2014	14/5/2014	6/5/2014	13/5/2014
	Saturday	17/5/2014	18/5/2014	10/5/2014	17/5/2014
	Tuesday	20/5/2014	21/5/2014	13/5/2014	20/5/2014
	Saturday	24/5/2014	25/5/2014	17/5/2014	24/5/2014
	Tuesday	27/5/2014	28/5/2014	20/5/2014	27/5/2014
	Saturday	31/5/2014	1/6/2014	24/5/2014	31/5/2014
June	Tuesday	3/6/2014	4/6/2014	27/5/2014	3/6/2014
	Saturday	7/6/2014	8/6/2014	31/5/2014	7/6/2014
	Tuesday	10/6/2014	11/6/2014	5/6/2014	9/6/2014
	Saturday	14/6/2014	15/6/2014	7/6/2014	14/6/2014
	Tuesday	17/6/2014	18/6/2014	10/6/2014	17/6/2014
	Saturday	21/6/2014	22/6/2014	14/6/2014	21/6/2014
	Tuesday	24/6/2014	25/6/2014	17/6/2014	24/6/2014
	Saturday	28/6/2014	29/6/2014	21/6/2014	28/6/2014
July	Tuesday	1/7/2014	2/7/2014	24/6/2014	1/7/2014
	Saturday	5/7/2014	6/7/2014	28/6/2014	5/7/2014
	Tuesday	8/7/2014	9/7/2014	1/7/2014	8/7/2014
	Saturday	12/7/2014	13/7/2014	5/7/2014	12/7/2014
	Tuesday	15/7/2014	16/7/2014	8/7/2014	15/7/2014
	Saturday	19/7/2014	20/7/2014	12/7/2014	19/7/2014
	Tuesday	22/7/2014	23/7/2014	15/7/2014	22/7/2014
	Saturday	26/7/2014	27/7/2014	19/7/2014	26/7/2014
	Tuesday	29/7/2014	30/7/2014	22/7/2014	29/7/2014
Aug	Saturday	2/8/2014	3/8/2014	26/7/2014	2/8/2014
	Tuesday	5/8/2014	6/8/2014	29/7/2014	5/8/2014
	Saturday	9/8/2014	10/8/2014	2/8/2014	9/8/2014
	Tuesday	12/8/2014	13/8/2014	5/8/2014	12/8/2014
	Saturday	16/8/2014	17/8/2014	9/8/2014	16/8/2014
	Tuesday	19/8/2014	20/8/2014	12/8/2014	19/8/2014
	Saturday	23/8/2014	24/8/2014	16/8/2014	23/8/2014
	Tuesday	26/8/2014	27/8/2014	19/8/2014	26/8/2014
	Saturday	30/8/2014	31/8/2014	23/8/2014	30/8/2014
September	Tuesday	2/9/2014	3/9/2014	26/8/2014	2/9/2014
	Saturday	6/9/2014	9/9/2014	30/8/2014	6/9/2014
	Tuesday	9/9/2014	10/9/2014	2/9/2014	9/9/2014
	Saturday	13/9/2014	14/9/2014	6/9/2014	13/9/2014

	Tuesday	16/9/2014	17/9/2014	9/9/2014	16/9/2014
	Saturday	20/9/2014	21/9/2014	13/9/2014	20/9/2014
	Tuesday	23/9/2014	24/9/2014	16/9/2014	23/9/2014
	Saturday	27/9/2014	28/9/2014	20/9/2014	27/9/2014
	Tuesday	30/9/2014	1/10/2014	23/9/2014	30/9/2014
October	Saturday	4/10/2014	5/10/2014	27/9/2014	4/10/2014
	Tuesday	7/10/2014	8/10/2014	30/9/2014	7/10/2014
	Saturday	11/10/2014	12/10/2014	4/10/2014	11/10/2014
	Tuesday	14/10/2014	15/10/2014	7/10/2014	14/10/2014
	Saturday	18/10/2014	19/10/2014	11/10/2014	18/10/2014
	Tuesday	21/10/2014	22/10/2014	14/10/2014	21/10/2014
	Saturday	25/10/2014	26/10/2014	18/10/2014	25/10/2014
	Tuesday	28/10/2014	29/10/2014	21/10/2014	28/10/2014

Table A 2: Price fluctuations

	Saturdays		**Tuesdays**		**Combined**	
	N = 3276	*%*	*N = 3276*	*%*	*N = 6552*	*%*
Count of room rate change						
0	71	2.17	137	4.18	208	3.17
1	171	5.22	241	7.36	412	6.29
2	312	9.52	371	11.32	683	10.42
3	460	14.04	493	15.05	953	14.55
4	609	18.59	560	17.09	1169	17.84
5	769	23.47	633	19.32	1402	21.4
6	571	17.43	527	16.09	1098	16.76
7	313	9.55	314	9.58	627	9.57
aggregate room rate change						
Decrease	1018	31.07	1,147	35.01	2165	33.04
Increase	2120	64.71	1853	56.56	3973	60.64
Zero/Unchanged	138	4.21	276	8.42	414	6.32

Table A 3: Correlation matrix

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Frequency	1												
2	Coefficient of variation	0.2079	1											
3	aggregate room rate change	-0.1697	0.0327	1										
4	Occupancy	0.1514	0.2425	0.1694	1									
5	Ln(demand)	0.1561	0.2386	0.1641	0.9986	1								
6	Ln(room rates)	-0.0026	-0.1404	-0.0246	0.2688	0.2674	1							
7	Ln(size)	0.0632	-0.0577	0.0283	0.0000	0.0000	0.0622	1						
8	Distance to airport	0.0379	-0.0127	0.0356	0.0000	0.0000	0.0315	-0.0217	1					
9	Distance to nearest train station	0.0475	0.0749	-0.0237	0.0000	0.0000	-0.2306	0.1449	-0.5177	1				
10	Mean distance to top attractions	-0.0532	0.094	0.0168	0.0000	0.0000	-0.221	0.2873	-0.2964	0.4277	1			
11	Hotel district occupancy	0.046	0.1347	0.0746	0.1956	0.1989	-0.0483	0.1416	-0.1041	0.0562	0.3259	1		
12	Star	0.0069	-0.1492	-0.0155	0.0000	0.0000	0.6071	0.2741	0.0049	-0.0267	-0.0433	-0.0683	1	
13	Hotel class	0.1126	0.0686	-0.0016	0.0000	0.0000	-0.1521	0.2892	0.2073	0.1072	0.2065	0.0948	-0.0159	1

Table A 4: Poisson regression results for frequency of price change (500m radius)

Variables	*Saturday*	*Tuesday*
Occupancy	0.0047***	0.0099***
	(2.69)	(10.02)
Seller density	0.0134***	0.0127**
	(2.58)	(2.16)
chain	-0.0110	0.0045
	(-0.28)	(0.09)
4-star	0.0654	0.0287
	(1.40)	(0.54)
5-star	-0.0795	-0.195**
	(-1.00)	(-2.16)
Medium-sized (101-300 rooms)	0.0974*	0.0386
	(1.75)	(0.61)
Large-sized (more than 300 rooms)	0.134**	0.111
	(2.27)	(1.65)
Midscale	-0.124	-0.170*
	(-1.61)	(-1.92)
Upper midscale	-0.0216	-0.0972
	(-0.29)	(-1.12)
Upper upscale	-0.00555	-0.0875
	(-0.07)	(-0.95)
Upscale	-0.0300	-0.0523
	(-0.40)	(-0.60)
Eastern & Southern	0.0495	0.0692
	(0.54)	(0.67)
New Territories	-0.0087	-0.105
	(-0.07)	(-0.73)
Other Kowloon	0.0289	-0.0441
	(0.36)	(-0.49)
Tsim Sha Tsui	-0.0306	-0.0459
	(-0.41)	(-0.49)
Wan Chai	0.0462	0.0138
	(0.68)	(0.18)
Yau Ma Tei & Mong Kok	0.0826	0.0852
	(1.30)	(1.17)
Distance to Airport	0.00635	0.00791
	(0.75)	(0.81)
Distance to nearest train station	0.0745*	0.109**
	(1.75)	(2.23)
Mean distance to top attractions	-0.00569	-0.00168
	(-0.44)	(-0.12)
Constant	0.702**	0.270
	(2.43)	(0.92)
Log likelihood	-6494.5955	-6632.1054
Wald chi2	51.86***	137.48***
Lnalpha_constant	-3.803***	-3.462***
	(-20.85)	(-20.53)

Ln_r_constant		
N	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 5: Poisson and Negative binomial regression results for frequency of price change (400m radius)

	Poisson		Negative binomial	
Variables	*Saturday*	*Tuesday*	*Saturday*	*Tuesday*
Occupancy	0.0047***	0.0099***	0.0047***	0.0099***
	(2.69)	(10.02)	(2.69)	(10.02)
Seller density	0.0146**	0.0140**	0.0146**	0.0140**
	(2.35)	(1.99)	(2.35)	(1.99)
chain	-0.0113	0.0137	-0.0113	0.0137
	(-0.03)	(0.30)	(-0.03)	(0.30)
4-star	0.0712	0.0342	0.0712	0.0342
	(1.52)	(0.64)	(1.52)	(0.64)
5-star	-0.0756	-0.192**	-0.0756	-0.192**
	(-0.95)	(-2.11)	(-0.95)	(-2.11)
Medium-sized (101-300 rooms)	0.0823	0.0243	0.0823	0.0243
	(1.49)	(0.39)	(1.49)	(0.39)
Large-sized (more than 300 rooms)	0.116**	0.0950	0.116**	0.0950
	(2.01)	(1.44)	(2.01)	(1.44)
Midscale	-0.118	-0.166*	-0.118	-0.166*
	(-1.53)	(-1.87)	(-1.53)	(-1.87)
Upper midscale	-0.0169	-0.0936	-0.0169	-0.0936
	(-0.22)	(-1.08)	(-0.22)	(-1.08)
Upper upscale	-0.00647	-0.0936	-0.00649	-0.0902
	(-0.08)	(-1.08)	(-0.08)	(-0.96)
Upscale	-0.0320	-0.0552	-0.0320	-0.0552
	(-0.42)	(-0.63)	(-0.42)	(-0.63)
Eastern & Southern	0.0444	0.0648	0.0445	0.0648
	(0.48)	(0.62)	(0.49)	(0.62)
New Territories	-0.0111	-0.107	-0.0111	-0.107
	(-0.09)	(-0.75)	(-0.09)	(-0.75)
Other Kowloon	0.0285	-0.0441	0.0285	-0.0441
	(0.36)	(-0.48)	(0.36)	(-0.48)
Tsim Sha Tsui	-0.00315	-0.0210	-0.00316	-0.0210
	(-0.04)	(-0.26)	(-0.04)	(-0.26)
Wan Chai	0.0565	0.0229	0.0565	0.0229
	(0.84)	(0.30)	(0.84)	(0.30)
Yau Ma Tei & Mong Kok	0.0892	0.0917	0.0892	0.0917
	(1.40)	(1.26)	(1.40)	(1.26)
Distance to Airport	0.00598	0.00757	0.00598	0.00757
	(0.70)	(0.77)	(0.70)	(0.77)
Distance to nearest train station	0.0751*	0.110**	0.0751*	0.110**
	(1.75)	(2.23)	(1.75)	(2.23)
Mean distance to top attractions	-0.00645	-0.00235	-0.00645	-0.00235
	(-0.50)	(-0.16)	(-0.50)	(-0.16)
Constant	0.726**	0.291	16.89***	16.70
	(2.51)	(0.99)	(49.50)	(0.14)
Log likelihood	-6495.1321	-6632.4389	-6495.1316	-6632.4385
Wald chi2	50.39***	136.58***	50.42***	136.59***
Lnalpha_constant	-3.790***	-3.455***	-3.790***	-3.455***
	(-20.86)	(-20.53)	(-20.86)	(-20.53)

Ln_r_constant			19.96	19.86
			(0.17)	(0.16)
N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 6: Poisson and Negative binomial regression results for frequency of price change (600m radius)

	Poisson		Negative binomial	
Variables	*Saturday*	*Tuesday*	*Saturday*	*Tuesday*
Occupancy	0.0047***	0.0099***	0.0047***	0.0099***
	(2.69)	(10.02)	(2.69)	(10.02)
Seller density	0.0103**	0.0105**	0.0103**	0.0105**
	(2.36)	(2.15)	(2.36)	(2.15)
chain	-0.00902	0.00547	-0.00902	0.00547
	(-0.23)	(0.12)	(-0.23)	(0.12)
4-star	0.0721	0.0349	0.0721	0.0349
	(1.54)	(0.65)	(1.54)	(0.65)
5-star	-0.0618	-0.179**	-0.0618	-0.179**
	(-0.78)	(-1.98)	(-0.78)	(-1.98)
Medium-sized (101-300 rooms)	0.0823	0.0258	0.0823	0.0258
	(1.50)	(0.41)	(1.50)	(0.41)
Large-sized (more than 300 rooms)	0.115**	0.0951	0.115**	0.0951
	(2.00)	(1.45)	(2.00)	(1.45)
Midscale	-0.0999	-0.149*	-0.0999	-0.149*
	(-1.31)	(-1.71)	(-1.31)	(-1.71)
Upper midscale	-0.00495	-0.0827	-0.00495	-0.0827
	(-0.07)	(-0.97)	(-0.07)	(-0.97)
Upper upscale	-0.0144	-0.0704	-0.0144	-0.0704
	(-0.18)	(-0.77)	(-0.18)	(-0.77)
Upscale	-0.0128	-0.0366	-0.0128	-0.0366
	(-0.17)	(-0.42)	(-0.17)	(-0.42)
Eastern & Southern	0.0431	0.0654	0.0431	0.0654
	(0.47)	(0.63)	(0.47)	(0.63)
New Territories	-0.0166	-0.111	-0.0166	-0.111
	(-0.13)	(-0.78)	(-0.13)	(-0.78)
Other Kowloon	0.0124	-0.0596	0.0124	-0.0596
	(0.16)	(-0.66)	(0.16)	(-0.66)
Tsim Sha Tsui	-0.0345	-0.0586	-0.0345	-0.0586
	(-0.44)	(-0.66)	(-0.44)	(-0.66)
Wan Chai	0.0490	0.0124	0.0490	0.0124
	(0.72)	(0.16)	(0.72)	(0.16)
Yau Ma Tei & Mong Kok	0.0797	0.0816	0.0797	0.0816
	(1.24)	(1.12)	(1.24)	(1.12)
Distance to Airport	0.00739	0.00904	0.00739	0.00904
	(0.86)	(0.92)	(0.86)	(0.92)
Distance to nearest train station	0.0739*	0.114**	0.0739*	0.114**
	(1.85)	(2.33)	(1.85)	(2.33)
Mean distance to top attractions	-0.00503	-0.0008	-0.00503	-0.0008
	(-0.39)	(-0.06)	(-0.39)	(-0.06)
Constant	0.665**	0.227	16.65***	15.74
	(2.28)	(0.77)	(48.45)	(0.19)
Log likelihood	-6495.1	-6632.122	-6495.0998	-6632.1229
Wald chi2	50.52***	137.45***	50.52***	137.45***
Lnalpha_constant	-3.791***	-3.461***	-3.791***	-3.461***
	(-20.86)	(-20.53)	(-20.86)	(-20.53)

Ln_r_constant			19.78	18.97
			(0.24)	(0.22)
N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 7: Logit regression results for pattern of price change (500m radius)

	Saturday		*Tuesday*	
Variables	*aggregate increase*	*aggregate decrease*	*aggregate increase*	*aggregate decrease*
Occupancy	0.152***	-0.149***	0.0851***	-0.0644***
	(16.38)	(-15.37)	(17.72)	(-12.95)
Seller density	-0.00387	0.0168	0.0228	-0.00071
	(-0.25)	(1.03)	(1.18)	(-0.04)
chain	-0.0921	0.0557	0.126	-0.116
	(-0.78)	(0.45)	(0.92)	(-0.82)
4-star	0.0306	0.0796	0.0942	-0.0747
	(0.20)	(0.48)	(0.64)	(-0.49)
5-star	0.0537	0.0390	-0.698***	0.306
	(0.20)	(0.13)	(-3.25)	(1.47)
Medium-sized (101-300 rooms)	0.341*	-0.206	0.417**	-0.444**
	(1.93)	(-0.96)	(2.37)	(-2.35)
Large-sized (more than 300 rooms)	0.193	-0.171	0.343*	-0.460**
	(1.16)	(-0.82)	(1.95)	(-2.53)
Midscale	0.619***	-0.503**	0.0642	-0.199
	(2.58)	(-1.97)	(0.29)	(-0.91)
Upper midscale	0.633***	-0.372	0.261	-0.430**
	(2.91)	(-1.62)	(1.21)	(-2.17)
Upper upscale	0.0700	0.190	-0.290	0.143
	(0.30)	(0.79)	(-1.33)	(0.64)
Upscale	0.403	-0.163	0.179	-0.302
	(1.58)	(-0.58)	(0.79)	(-1.34)
Eastern & Southern	-0.925**	1.046***	-0.294	0.506
	(-2.51)	(3.20)	(-0.81)	(1.44)
New Territories	-0.419	0.562	-0.801*	0.699
	(-0.99)	(1.21)	(-1.73)	(1.44)
Other Kowloon	-0.516*	0.728***	-0.779***	1.000***
	(-1.87)	(2.61)	(-3.07)	(3.97)
Tsim Sha Tsui	-0.174	0.268	-0.490*	0.512*
	(-0.77)	(1.12)	(-1.93)	(1.93)
Wan Chai	-0.383*	0.430**	-0.374	0.402*
	(-1.75)	(2.02)	(-1.65)	(1.78)
Yau Ma Tei & Mong Kok	-0.568***	0.657***	-0.368	0.603***
	(-2.78)	(3.08)	(-1.64)	(2.78)
Distance to Airport	0.120***	-0.125***	0.0945***	-0.0752**
	(3.73)	(-3.90)	(2.73)	(-2.17)
Distance to nearest train station	0.414***	-0.329**	0.0918	0.144
	(3.19)	(-2.29)	(0.82)	(1.43)
Mean distance to top attractions	0.0402	-0.0459	0.0704	-0.0493
	(0.80)	(-0.85)	(1.42)	(-1.01)
Constant	-16.41***	15.54***	-9.766***	6.936***
	(-13.29)	(11.98)	(-9.84)	(6.75)
Log pseudolikelihood	-1901.2337	-1820.4401	-1970.9444	-1942.5079
Wald chi2	346.21***	326.81***	389.18***	264.71***
Lnsig2u_constant	-1.944***	-1.765***	-1.714***	-1.703***
	(-5.23)	(-5.30)	(-6.06)	(-5.88)

N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 8: Logit regression results for pattern of price change (400m radius)

	Saturday		*Tuesday*	
	aggregate increase	*aggregate decrease*	*aggregate increase*	*aggregate decrease*
Occupancy	0.152***	-0.149***	0.0851***	-0.0644***
	(16.38)	(-15.37)	(17.72)	(-12.95)
Seller density	-0.0105	0.0199	0.0170	0.0051
	(-0.66)	(1.25)	(0.82)	(0.23)
chain	-0.0956	0.0678	0.141	-0.117
	(-0.80)	(0.55)	(1.00)	(-0.81)
4-star	0.0294	0.0866	0.105	-0.0753
	(0.19)	(0.52)	(0.72)	(-0.50)
5-star	0.0604	0.0420	-0.682***	0.299
	(0.22)	(0.14)	(-3.22)	(1.48)
Medium-sized (101-300 rooms)	0.342**	-0.223	0.390**	-0.440**
	(2.01)	(-1.08)	(2.28)	(-2.44)
Large-sized (more than 300 rooms)	0.188	-0.189	0.304*	-0.440**
	(1.17)	(-0.95)	(1.82)	(-2.63)
Midscale	0.634***	-0.500**	0.0944	-0.216
	(2.69)	(-2.01)	(0.43)	(-1.01)
Upper midscale	0.647***	-0.370	0.286	-0.444**
	(2.99)	(-1.63)	(1.34)	(-2.26)
Upper upscale	0.0915	0.183	-0.266	0.124
	(0.38)	(0.75)	(-1.18)	(0.54)
Upscale	0.416	-0.169	0.191	-0.313
	(1.60)	(-0.60)	(0.84)	(-1.37)
Eastern & Southern	-0.936**	1.042***	-0.319	0.517
	(-2.54)	(3.20)	(-0.88)	(1.47)
New Territories	-0.425	0.559	-0.815*	0.705
	(-1.01)	(1.20)	(-1.76)	(1.41)
Other Kowloon	-0.525*	0.729***	-0.792***	1.008***
	(-1.90)	(2.64)	(-3.08)	(3.98)
Tsim Sha Tsui	-0.143	0.291	-0.397*	0.474**
	(-0.69)	(1.39)	(-1.74)	(1.99)
Wan Chai	-0.362*	0.437**	-0.330	0.380*
	(-1.66)	(2.05)	(-1.49)	(1.71)
Yau Ma Tei & Mong Kok	-0.567***	0.663***	-0.355	0.600
	(-2.77)	(3.12)	(-1.59)	(2.78)
Distance to Airport	0.120***	-0.125***	0.0938***	-0.0750**
	(3.73)	(-3.92)	(2.70)	(-2.16)
Distance to nearest train station	0.413***	-0.328**	0.0919	0.144
	(3.19)	(-2.29)	(0.83)	(1.44)
Mean distance to top attractions	0.0396	-0.0465	0.0683	-0.0486
	(0.80)	(-0.86)	(1.40)	(-1.00)
Constant	-16.40***	15.57***	-9.708***	6.919***
	(-13.27)	(11.99)	(-9.79)	(6.76)
Log pseudolikelihood	-1901.1283	-1820.4433	-1971.4258	-1942.4806
Wald chi2	346.37***	326.80***	388.45***	264.77***
Lnsig2u_constant	-1.948***	-1.765***	-1.700***	-1.705***
	(-5.22)	(-5.32)	(-6.02)	(-5.88)

N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 9: Probit regression results for pattern of price change (400m radius)

	Saturday		*Tuesday*	
	aggregate increase	*aggregate decrease*	*aggregate increase*	*aggregate decrease*
Occupancy	0.0916***	-0.0893***	0.0515***	-0.0390***
	(16.99)	(-15.90)	(17.98)	(-12.94)
Seller density	-0.0064	0.0118	0.0103	0.00284
	(-0.68)	(1.26)	(0.82)	(0.21)
chain	-0.0580	0.0418	0.0829	-0.0715
	(-0.81)	(0.57)	(0.99)	(-0.84)
4-star	0.0183	0.0508	0.0653	-0.0418
	(0.19)	(0.51)	(0.75)	(-0.47)
5-star	0.0374	0.0283	-0.406***	0.187
	(0.23)	(0.17)	(-3.24)	(1.53)
Medium-sized (101-300 rooms)	0.205**	-0.130	0.238**	-0.264**
	(2.02)	(-1.06)	(2.34)	(-2.44)
Large-sized (more than 300 rooms)	0.117	-0.114	0.189*	-0.270**
	(1.19)	(-0.96)	(1.91)	(-2.66)
Midscale	0.378***	-0.300**	0.0550	-0.130
	(2.65)	(-2.04)	(0.42)	(-1.02)
Upper midscale	0.379***	-0.214	0.168	-0.270**
	(2.91)	(-1.60)	(1.31)	(-2.30)
Upper upscale	0.0534	0.105	-0.169	0.0784
	(0.36)	(0.72)	(-1.26)	(0.57)
Upscale	0.246	-0.0992	0.110	-0.191
	(1.59)	(-0.60)	(0.81)	(-1.40)
Eastern & Southern	-0.546**	0.596***	-0.191	0.311
	(-2.48)	(3.10)	(-0.88)	(1.50)
New Territories	-0.254	0.336	-0.496*	0.430
	(-1.02)	(1.25)	(-1.82)	(1.46)
Other Kowloon	-0.308*	0.417**	-0.478***	0.603***
	(-1.88)	(2.57)	(-3.11)	(3.99)
Tsim Sha Tsui	-0.0763	0.162	-0.237*	0.278**
	(-0.62)	(1.33)	(-1.76)	(1.97)
Wan Chai	-0.207	0.251**	-0.195	0.224*
	(-1.60)	(2.03)	(-1.49)	(1.71)
Yau Ma Tei & Mong Kok	-0.328***	0.379***	-0.215	0.360**
	(-2.67)	(3.00)	(-1.62)	(2.22)
Distance to Airport	0.0690***	-0.0712***	0.0557***	-0.0442**
	(3.71)	(-3.00)	(2.77)	(-2.20)
Distance to nearest train station	0.241***	-0.192**	0.0568	0.0834
	(3.20)	(-2.30)	(0.86)	(1.41)
Mean distance to top attractions	0.0233	-0.0268	0.0406	-0.0287
	(0.81)	(-0.87)	(1.42)	(-1.01)
Constant	-9.779***	9.236***	-5.845***	4.164***
	(-13.80)	(12.43)	(-10.12)	(6.94)
Log pseudolikelihood	-1901.994	-1820.8855	-1972.2162	-1942.6642
Wald chi2	375.27***	349.38***	424.35***	276.86***
Lnsig2u_constant	-2.976***	-2.826***	-2.758***	-2.754***
	(-7.97)	(-8.46)	(-9.88)	(-9.63)

N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 10: Logit regression results for pattern of price change (600m radius)

	Saturday		*Tuesday*	
	aggregate increase	*aggregate decrease*	*aggregate increase*	*aggregate decrease*
Occupancy	0.152***	-0.149***	0.0851***	-0.0644***
	(16.38)	(-15.37)	(17.72)	(-12.95)
Seller density	-0.0108	0.00036	0.0237	-0.00593
	(-0.90)	(0.03)	(1.43)	(-0.36)
chain	-0.100	0.0650	0.125	-0.113
	(-0.85)	(0.53)	(0.92)	(-0.80)
4-star	0.0290	0.0880	0.106	-0.0751
	(0.19)	(0.53)	(0.73)	(-0.49)
5-star	0.0439	0.0666	-0.667***	0.307
	(0.17)	(0.23)	(-3.18)	(1.50)
Medium-sized (101-300 rooms)	0.353*	-0.231	0.398**	-0.447**
	(2.04)	(-1.10)	(2.32)	(-2.45)
Large-sized (more than 300 rooms)	0.227	-0.219	0.327*	-0.471**
	(1.36)	(-1.08)	(1.94)	(-2.71)
Midscale	0.585***	-0.447*	0.0948	-0.190
	(2.54)	(-1.86)	(0.44)	(-0.92)
Upper midscale	0.600***	-0.325	0.277	-0.420**
	(2.86)	(-1.48)	(1.30)	(-2.17)
Upper upscale	0.0263	0.249	-0.272	0.157
	(0.11)	(1.09)	(-1.28)	(0.74)
Upscale	0.385	-0.130	0.206	-0.298
	(1.53)	(-0.48)	(0.91)	(-1.35)
Eastern & Southern	-0.884**	1.003***	-0.287	0.492
	(-2.41)	(3.07)	(-0.79)	(1.40)
New Territories	-0.399	0.536	-0.805*	0.693
	(-0.94)	(1.14)	(-1.73)	(1.40)
Other Kowloon	-0.501*	0.699***	-0.800***	0.997***
	(-1.88)	(2.56)	(-3.28)	(4.07)
Tsim Sha Tsui	-0.334	0.409*	-0.571**	0.576**
	(-1.47)	(1.68)	(-2.04)	(2.07)
Wan Chai	-0.464**	0.507**	-0.405*	0.433*
	(-2.18)	(2.44)	(-1.73)	(1.87)
Yau Ma Tei & Mong Kok	-0.585***	0.670***	-0.382*	0.611***
	(-2.89)	(3.11)	(-1.70)	(2.80)
Distance to Airport	0.122***	-0.126***	0.0972***	-0.0762**
	(3.84)	(-3.97)	(2.81)	(-2.20)
Distance to nearest train station	0.420***	-0.330**	0.103	0.140
	(3.26)	(-2.32)	(0.90)	(1.38)
Mean distance to top attractions	0.0439	-0.0488	0.0732	-0.0509
	(0.84)	(-0.88)	(1.45)	(-1.03)
Constant	-16.53***	15.61***	-9.888***	6.991***
	(-13.32)	(11.95)	(-9.79)	(6.69)
Log pseudolikelihood	-1900.9792	-1820.8594	-1970.5089	-1942.4326
Wald chi2	346.60***	326.16***	389.90***	264.82***
Lnsig2u_constant	-1.951***	-1.749***	-1.728***	-1.705***
	(-5.29)	(-5.35)	(-6.06)	(-5.90)

N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Table A 11: Probit regression results for pattern of price change (600m radius)

	Saturday		*Tuesday*	
	aggregate increase	*aggregate decrease*	*aggregate increase*	*aggregate decrease*
Occupancy	0.0916***	-0.0893***	0.0515***	-0.0390***
	(16.99)	(-15.90)	(17.99)	(-12.94)
Seller density	-0.00654	0.00005	0.0143	-0.0036
	(-0.91)	(0.01)	(1.44)	(-0.38)
Chain	-0.0607	0.0403	0.0734	-0.0695
	(-0.86)	(0.55)	(0.90)	(-0.82)
4-star	0.0181	0.0515	0.0664	-0.0418
	(0.19)	(0.52)	(0.76)	(-0.46)
5-star	0.0274	0.0427	-0.397***	0.191
	(0.17)	(0.25)	(-3.19)	(1.57)
Medium-sized (101-300 rooms)	0.211**	-0.134	0.243**	-0.268**
	(2.04)	(-1.08)	(2.39)	(-2.46)
Large-sized (more than 300 rooms)	0.140	-0.133	0.203**	-0.283***
	(1.39)	(-1.09)	(2.03)	(-2.74)
Midscale	0.348**	-0.268*	0.0556	-0.116
	(2.49)	(-1.88)	(0.43)	(-0.93)
Upper midscale	0.350***	-0.187	0.172	-0.256**
	(2.77)	(-1.45)	(1.37)	(-2.21)
Upper upscale	0.0137	0.145	-0.172	0.0979
	(0.10)	(1.05)	(-1.37)	(0.77)
Upscale	0.227	-0.0762	0.119	-0.183
	(1.51)	(-0.48)	(0.89)	(-1.38)
Eastern & Southern	-0.515**	0.573***	-0.172	0.296
	(-2.36)	(2.97)	(-0.80)	(1.43)
New Territories	-0.238	0.323	-0.489*	0.422
	(-0.95)	(1.19)	(-1.79)	(1.43)
Other Kowloon	-0.293*	0.400***	-0.482***	0.596***
	(-1.85)	(2.49)	(-3.32)	(4.09)
Tsim Sha Tsui	-0.193	0.234	-0.342**	0.339*
	(-1.42)	(1.64)	(-2.06)	(2.04)
Wan Chai	-0.269**	0.294**	-0.241*	0.256*
	(-2.13)	(2.42)	(-1.73)	(1.87)
Yau Ma Tei & Mong Kok	-0.339***	0.383***	-0.231	0.367***
	(-2.79)	(2.99)	(-1.72)	(2.82)
Distance to Airport	0.0702***	-0.0715***	0.0578***	-0.0449**
	(3.84)	(-3.94)	(2.88)	(-2.23)
Distance to nearest train station	0.245***	-0.193**	0.0636	0.0808
	(3.27)	(-2.34)	(0.94)	(1.34)
Mean distance to top attractions	0.0259	-0.0281	0.0435	-0.0301
	(0.86)	(-0.88)	(1.48)	(-1.04)
Constant	-9.856***	9.266***	-5.953***	4.207***
	(-13.88)	(12.41)	(-10.14)	(6.88)
Log pseudolikelihood	-1901.847	-1821.3074	-1971.2786	-1942.6062
Wald chi2	375.51***	348.61***	426.30***	276.94***
Lnsig2u_constant	-2.978***	-2.809***	-2.787***	-2.754***
	(-8.09)	(-8.54)	(-9.88)	(-9.67)

N	3276	3276	3276	3276

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for distric

Table A 12: Spatial regression results for Saturday pricing (500m radius)

	OLS	*SAR*	*SEM*	*SDM*
ln(demand)	0.303***	0.210***	0.304***	0.237***
	(8.16)	(5.59)	(5.05)	(3.55)
Seller density	-0.00146**	-0.00389***	-0.000153**	-0.00017**
	(-2.06)	(-4.78)	(-2.07)	(-2.17)
Ln(starting price)	-0.0461***	-0.0428***	-0.0419***	-0.0439***
	(-3.62)	(-3.32)	(-2.99)	(-2.98)
Ln(size)	-0.0127***	-0.0128	-0.0130***	-0.0128***
	(-3.39)	(-3.37)	(-3.52)	(-2.98)
Frequency	0.0584***	0.0611***	0.0721***	0.0758***
	(8.56)	(9.07)	(10.40)	(10.34)
Chain	0.0071	0.00698	0.00064	0.00642
	(1.17)	(1.11)	(1.05)	(1.04)
4-star	0.0150**	0.0117	0.0135*	0.0177**
	(2.05)	(1.58)	(1.84)	(2.27)
5-star	0.0309*	0.0272**	0.0287**	0.0340**
	(2.44)	(2.05)	(2.19)	(2.48)
Midscale	0.0374***	0.0363***	0.0394***	0.0477***
	(4.22)	(3.79)	(4.38)	(5.05)
Upper midscale	0.0418***	0.0430***	0.0428***	0.0453***
	(4.11)	(3.99)	(4.20)	(4.23)
Upper upscale	0.0183*	0.0176*	0.0187**	0.0226*
	(1.94)	(1.69)	(1.98)	(1.71)
Upscale	0.0272***	0.0277**	0.0283***	0.0278***
	(2.65)	(2.51)	(2.73)	(2.64)
Eastern & Southern	-0.0039	-0.00345	-0.004	-0.0123
	(-0.28)	(-0.23)	(-0.27)	(-0.38)
New Territories	0.0626***	0.0665***	0.0626***	0.0301
	(3.58)	(3.62)	(3.48)	(0.77)
Other Kowloon	-0.00540	-0.00305	-0.00463	-0.00098
	(-0.50)	(-0.26)	(-0.41)	(-0.03)
Tsim Sha Tsui	0.0196**	0.0139	0.0191*	0.0461
	(2.05)	(1.37)	(1.95)	(1.61)
Wan Chai	0.0071	0.00013	0.00716	0.00799
	(0.67)	(0.01)	(0.63)	(0.29)
Yau Ma Tei & Mong Kok	0.00191	-0.0098	0.00083	0.0242
	(0.20)	(-0.99)	(0.08)	(0.71)
Distance to Airport	-0.00053	-0.000759	-0.00047	-0.00074
	(-0.41)	(-0.54)	(-0.35)	(-0.42)
Distance to nearest train	-0.000359	0.00013	-0.00033	-0.0265
station	(-0.06)	(0.02)	(-0.05)	(-0.38)
Mean distance to top	-0.0023	-0.00131	-0.00214	-0.00271
attractions	(-1.53)	(-0.83)	(-1.39)	(-1.48)
Constant	-2.857***	-1.885***	-2.904***	-2.108***
	(-8.10)	(-5.22)	(-4.77)	(-3.22)
Lambda			0.824***	
			(13.68)	
Rho		0.687***		0.731***
		(10.75)		(11.65)

Variance lgt_theta		0.323**		0.469*
		(2.12)		(2.39)
Variance ln_phi			-2.673***	
			(-12.92)	
Sigma_e		0.00593***		0.00585***
		(14.96)		(14.89)
Sigma2_e			0.00585***	
			(14.80)	
N	3276	3276	3276	3276
Wald	466.32			
Prob>chi2	0.0000			
LR test				
AIC		-7286.386	-7325.178	-7309.062
BIC		-7134.026	-7172.178	-7028.721
L-pseudolikelihood		3668.1929	3687.5888	3700.5311
LM test				
Pr(LM)				

Notes: t-statistics in parenthesis; standard errors are robust ; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; 3-star is the comparison hotel for star rating; luxury hotels is reference group for class and Central & Western is the comparison group for district.

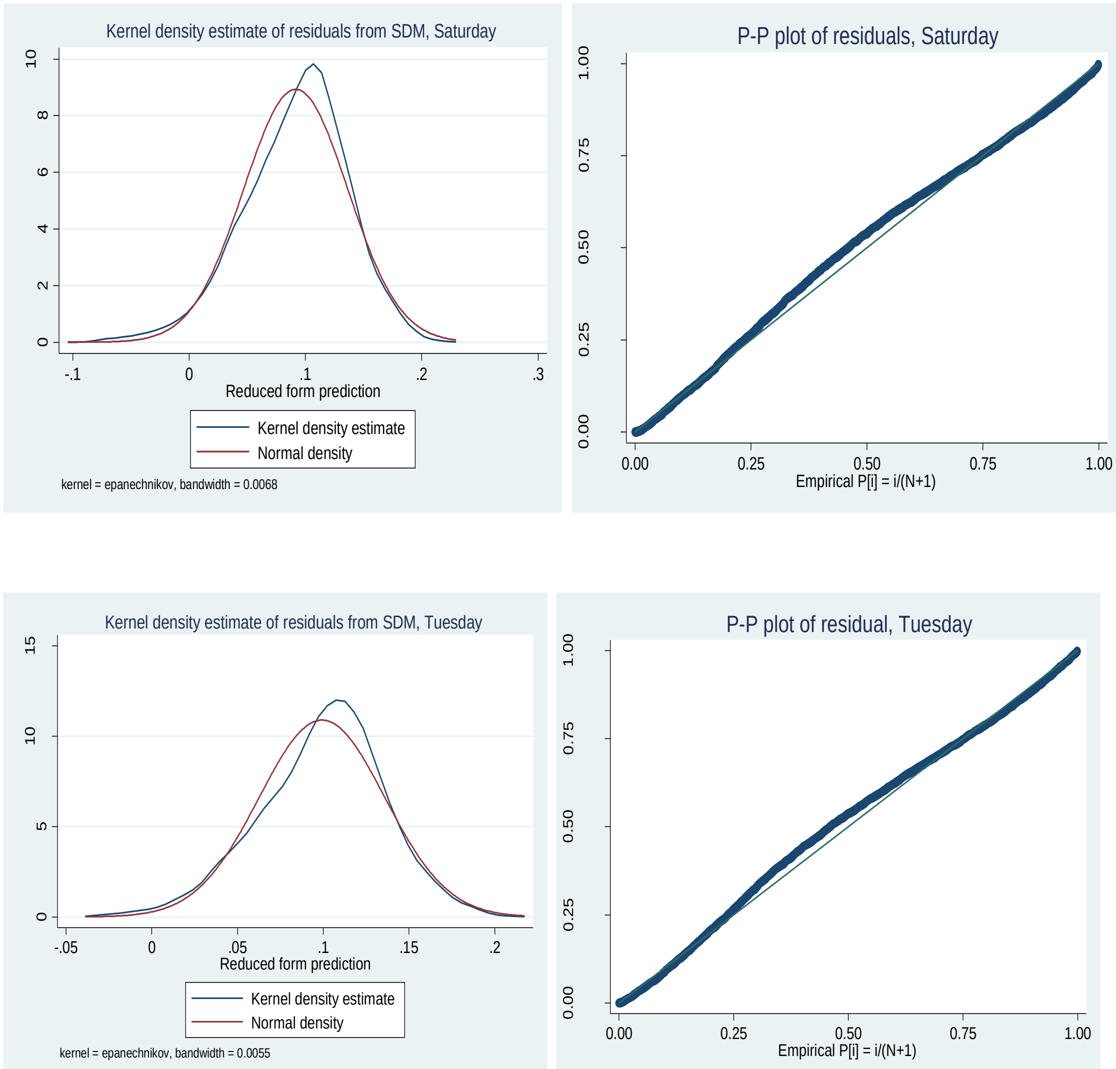
Table A 13: Spatial regression results for Tuesday pricing (500m)

	OLS	*SAR*	*SEM*	*SDM*
ln(demand)	0.178***	0.123***	0.177***	0.187***
	(12.41)	(7.75)	(8.12)	(7.01)
Seller density	-0.00049	-0.00239***	-0.00059	-0.0083***
	(-0.76)	(-3.42)	(-0.89)	(-2.91)
Ln(starting price)	-0.0179***	-0.0171***	-0.0158**	-0.0187***
	(-3.18)	(-3.03)	(-2.49)	(-2.71)
Ln(size)	-0.0137***	-0.0140***	-0.0140***	-0.0122***
	(-4.28)	(-4.23)	(-4.39)	(-3.5)
Frequency	0.0600***	0.0582***	0.0669***	0.0688***
	(11.14)	(10.78)	(11.77)	(11.84)
Chain	0.00287	0.00352	0.00282	0.00114
	(0.54)	(0.63)	(0.53)	(0.19)
4-star	0.00636	0.00479	0.00599	0.0153**
	(1.09)	(0.80)	(1.01)	(2.29)
5-star	0.00515	0.00361	0.00456	0.0141
	(0.52)	(0.36)	(0.46)	(1.09)
Midscale	0.0262***	0.0249***	0.079***	0.0311***
	(3.08)	(2.84)	(3.19)	(3.32)
Upper midscale	0.0288***	0.0290***	0.0295***	0.0269***
	(3.05)	(2.99)	(3.13)	(2.62)
Upper upscale	0.0132	0.0128	0.0139	0.00613
	(1.55)	(1.48)	(1.62)	(0.53)
Upscale	0.0195*	0.0190*	0.0199*	0.0212**
	(1.82)	(1.78)	(1.83)	(2.09)
Eastern & Southern	-0.0121	-0.0106	-0.0119	-0.0234
	(-1.09)	(-0.94)	(-1.04)	(-0.87)
New Territories	0.0420***	0.0456***	0.0417***	-0.0135
	(2.87)	(3.01)	(2.79)	(-0.40)
Other Kowloon	-0.0150	-0.0124	-0.0139	-0.0204
	(-1.38)	(-1.11)	(-1.25)	(-0.76)
Tsim Sha Tsui	-0.00236	-0.0043	-0.0017	0.00327
	(-0.25)	(-0.45)	(-0.17)	(0.14)
Wan Chai	-0.00912	-0.0128	-0.00894	-0.0142
	(-0.93)	(-1.33)	(-0.88)	(-0.61)
Yau Ma Tei & Mong Kok	-0.0155*	-0.0211**	-0.0147	0.00978
	(-1.74)	(-2.31)	(-1.55)	(0.33)
Distance to Airport	0.00074	0.00042	0.00062	-0.00268**
	(0.51)	(0.32)	(0.42)	(-2.21)
Distance to nearest train station	0.00489	0.00515	0.00475	-0.00406
	(1.14)	(1.19)	(1.12)	(-0.85)
Mean distance to top attractions	0.0039***	-0.00328**	-0.00384***	-0.0046***
	(-2.85)	(-2.35)	(-2.77)	(-3.59)
Constant	-1.704***	-1.118***	-1.709***	-1..672***
	(-11.68)	(-6.61)	(-7.40)	(-6.06)
Lambda			0.775***	
			(12.33)	
Rho		0.687***		0.731***
		(10.75)		(11.65)

Variance lgt_theta		0.323**		0.469*
		(2.12)		(2.39)
Variance ln_phi			-2.516***	
			(-12.94)	
Sigma_e		0.00593***		0.00585***
		(14.96)		(14.89)
Sigma2_e			0.00473***	
			(14.888)	
N	3276	3276	3276	3276
Wald	622.08			
Prob>chi2	0.0000			
LR test				
AIC		-7978.285	-8013.092	-7309.062
BIC		-7825.926	-78860.733	-7028.721
L-pseudolikelihood		4014.1425	4031.5461	3700.5311
LM test				
Pr(LM)				

Notes: t-statistics in parenthesis; standard errors are robust ; * p < 0.1; ** p < 0.05; *** p < 0.01; 3-star is the comparison hotel for star rating; small hotel (less than 100 rooms) is the reference group for size; luxury hotels is reference group for class and Central & Western is the comparison group for district.

Figure A 1: Graphical display of normality



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