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AN EMPIRICAL ANALYSIS OF OLIGOPOLISTIC HOTEL PRICING

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Abstract: Inflexible supply and volatile demand make the resort industry one where the effects of oligopoly are destabilizing. Theoretical Ricardian models predict that such instability should be asymmetrically related to the state of demand. High and stable prices characterize periods of excess demand. However periods of excess supply are characterized by prices that are downwardly inflexible and do not reflect the true state of demand. Data from Bermuda resort hotels are used to test these predictions. The study found that during periods of excess demand, prices are well-behaved. However, during periods of excess supply, prices are unrepresentative of the state of demand. Thus, the Ricardian model is supported by the data. **Keywords:** Ricardian rent, oligopoly, resorts, forecasting, island tourism

Résumé: Une analyse empirique des prix d'hôtel oligopolistiques. L'industrie hôtelière, avec son inflexibilité de l'offre et la volatilité de la demande, est sujette aux effets déstabilisants de l'oligopole. Selon le modèle ricardien, cette instabilité aurait un rapport asymétrique avec un excès de la demande. Cependant l'excès de l'offre mène à une baisse des prix inflexible et cache la vraie condition de la demande. On utilise l'exemple des stations touristiques des Bermudes pour mettre ce modèle à l'épreuve. Pendant les périodes d'excès de la demande, les prix réagissent au marché. Pourtant durant les périodes d'excès de l'offre, les prix sont peu représentatifs de la demande, ce qui corrobore le modèle ricardien. **Mots-clés:** loyer ricardien, oligopole, stations touristiques, prévisions, tourisme dans les îles.

INTRODUCTION

Products of the resort hotel industry have characteristics that make their supply relatively inflexible. The number of hotel rooms or other units of accommodation cannot be changed overnight. Yet the industry faces demand that tends to be highly volatile. These two factors make the industry conform closely to the theoretical Ricardian model of rent generation. Ricardian analysis offers several insights into the process of price-setting and demand forecasting in the industry. In this paper, the Bermuda resort hotel industry is used as a case study to illustrate such analysis.

In a competitive market, Ricardian analysis predicts that the price of the marginal unused unit (the empty hotel room whose neighbor is occupied) will be competed down to zero. Competitive hotels will be

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willing to let unrented rooms for virtually nothing, provided that the marginal revenue from other hotel services justify this strategy. In an oligopolistic situation, this need not occur. Oligopolistic hotels recognize their interdependence and know that by adjusting availability, they can influence price. Hence it is likely that in periods when demand is expected to be slack, rooms may be renovated (and hence unavailable for rental) or wings may be closed down. This has the added benefit of savings in terms of material and labor costs.

Such strategies involving the withdrawal of hotel rooms from the market may be termed "withholding" strategies. They are unavailable in the competitive case because of the complete absence of market power. A competitive player is a small operator and does not control enough units to influence price. Hence withholding offers no or, at best, limited strategic advantage. However, an oligopolistic player controls a large proportion of units and can influence price through varying availability. Thus withholding strategies become crucially important. Actually, it may be shown that withholding strategies introduce considerable instability into the market. Further, this instability can appear only in the case of excess supply. In the case of excess demand, both competitive and oligopolistic operators are able to extract maximal revenue from their units.

This paper has two objectives. The first is to test the predictions of the Ricardian model within the context of the resort industry. The second is to address the impact of changing demand through fluctuating arrivals on hotel occupancy within the specific context of island tourism. In undertaking this task, this paper complements the technique of yield management, which has gained wide acceptance and is extensively used all over the world, particularly within larger hotel organizations. This technique, which originated in the airline industry and gained ground in the hospitality sector from the mid-1980s onwards, is designed to assist hotels to go beyond traditional occupancy objectives and achieve maximum revenue from each room available for sale. The literature on yield management is relatively extensive and good illustrations include Orkin (1988); Relihan (1989); Lockwood and Jones (1990); Russo (1991); Jones and Hamilton (1992); Shaw (1992); and Lieberman (1993). This paper attempts to go beyond the environment of the individual property or discrete hotel corporation and apply Ricardian techniques as an alternative mechanism by which destinations can attain maximum yield from their accommodation stock.

Island tourism represents an ideal source for the testing of this approach to supply and demand analysis. Islands do have characteristics which set them apart from other tourism destinations. Baum (1993) identifies a number of characteristics of island tourism which accentuate these differentials. These include a high economic dependence on a small range of industries and products, tourism being one; a focused and, frequently, limited range of tourism products; targeting of high spend tourism, often long-haul markets requiring 5-star or equivalent product standards; a high level of foreign investment in resort facilities, imposing multinational standards without much scope for local interpretation; a restricted pool of skilled personnel with the aptitude, training, and language requirements for employment in the international tourism industry, reflecting limited service industry culture and traditions; and limited or non-existent education and training facilities for tourism.

While not all these characteristics are directly applicable to this case-study destination, Bermuda, the island does, in fact, represent an ideal location for the purposes of this study. In particular, Bermuda, as a vacation destination, has a number of features that make it particularly suited to a discussion of this nature. These include Bermuda's remote location in the west Atlantic, which means that it is very unlikely to act as a "shared" destination with any other location, in that it is not a likely participant in dual or multiple destination packaging. Second, its size means that data collection, relating to Bermuda, is likely to be far more complete than is the case with other destinations, where inaccuracies through sampling may affect analysis. Additional factors include Bermuda's high dependence on one relatively homogeneous market. With respect to arrivals and the characteristics of visitor stays, the United States accounts for approximately 82% of air arrivals and 92% of cruiseship visitors, mainly from the mid-Atlantic and north-eastern states (Department of Tourism 1993a). Another factor is the small number of major hotels on the island; the seven utilized in this study accounted for almost 60% of the total accommodation units on the island in 1991 (Archer 1992).

TOURISM AND ACCOMMODATIONS IN BERMUDA

Before embarking on the analysis, it is valuable to provide a brief introduction to the tourism and hotel environment within which this discussion has been based. Bermuda, as a destination, has certain characteristics that appear to set it apart from many competitor islands, for example those further south in the Caribbean. According to Brown and Riley,

> Bermuda has always marketed itself as an upscale tourist location, a place for fun and frolic and relaxation for the wealthy and well-known. Assiduously avoiding any characterisation as a mass market tourist destination, Bermuda has eschewed introducing any new approaches aimed primarily at increasing the number of tourists with deeply discounted packages or mass appeal entertainment—such as gambling or amusement.

This approach to marketing of the island was one which appears to have been relatively successful during the years of growth, up to the late 1970s. But the experience of the 1980s demonstrated the island's vulnerability to fluctuations with respect to economic and political factors within its main originating market, the United States. The influence of currency changes and international tensions and terrorism has had a marked effect on the number of tourists visiting the island. At the same time, the underlying trend within land-based tourism (those visitors using hotel stock within their visit) is downwards, with 1992 marking a 15-year low. Arrivals data for the period in question are shown in Table 1. The underlying decline in tourist arrivals has

Table 1. Annual Tourist Arrivals in Bermuda (1980–1992)

Year	Air Arrivals	Cruise Arrivals	Total Arrivals	% USA
1980	491,640	117,916	609,556	88
1981	429,801	105,445	535,246	89
1982	420,288	124,178	544,466	88
1983	446,864	120,846	567,710	88
1984	417,461	111,410	528,871	88
1985	406,687	142,903	549,590	89
1986	459,711	132,202	591,913	89
1987	477,877	153,437	631,314	89
1988	426,850	158,368	585,218	88
1989	418,273	131,322	549,595	86
1990	434,909	112,551	547,460	86
1991	386,178	128,151	514,329	86
1992	375,231	131,006	506,237	85

Source: Department of Tourism (1991 and 1993a).

been reflected in both annual average hotel occupancy performance and average length of stay of visitors since 1980. Table 2 summarizes this data for the period 1980–1992.

Brown and Riley (1993) acknowledge international factors behind this decline but they also note that "part of the reason why Bermuda has lost some of its lustre in that exclusive domain is that its value has been threatened in a number of areas, externally and internally" (1993: 257). They acknowledge factors such as recession but also point to a number of internal product — and environment — related deficiencies as factors in accelerating the decline. Archer (1992) also emphasizes the weather-induced seasonal nature of Bermuda tourism: the island has

Table 2. Annual Occupancy and Average Length in Hotels (1980–1992)

Year	Average Occupancy (%)	Average Length of Stay (days)
1980	73.9	5.1
1981	60.1	5.0
1982	58.8	5.2
1983	63.9	5.0
1984	60.7	4.9
1985	65.0	4.9
1986	68.5	4.9
1987	67.1	5.0
1988	60.5	4.9
1989	65.2	4.9
1990	66.4	4.9
1991	59.9	4.8
1992	54.9	4.6

Source: Bermuda Hotel Association (1993).

not countered low occupancies during the off-season like such other island destinations as Hawaii (Cook 1993).

This paper uses accommodation indicators, primarily derived with respect to large resort hotels, as the main gauge of the relationship between supply and demand within Bermuda tourism. The Bermuda accommodation stock consists of a diversity of prestige large resort hotels, smaller establishments, cottage colonies (a unique Bermudan type of establishment), and guest houses. The accent is basically on quality accommodation and some of the smaller hotels are also of exceptional standard, falling into what might be called the boutique category. The hotels, which form the basis for the discussion here, are the larger properties on the island but, even within that categorization, show considerable variation in their range of facilities and the services on offer. This caveat is of some importance to the theoretical discussion in this paper.

Recognition of the overall decline in arrivals is reflected in the embargo on new hotel construction, which has been in place since 1980, and, combined with the loss of a number of small hotels, has contributed to an overall reduction in hotel stock. This reduction in hotel rooms has been something in the order of 8% between 1980 and 1992 (Department of Tourism 1993b).

Dodswell (1993) notes the steady erosion of profits within the hotel sector in Bermuda since 1980, commenting that "the hotel industry as a whole has seen red ink for the past four years." While Dodswell speaks from the position of someone with a clear vested interest in the issues under discussion, it is worth noting that he continues by arguing that the problems faced by hotels are the result of very high and inflexible operating costs, especially with respect to labor.

> Labor is at a minimum of approximately US $10 per hour. Utility rates are triple those in the United States. All of our supplies must be imported from abroad with high shipping, government duty and delivery costs. As a result we cannot lower our hotel rates and yet we have been criticized that prices are too high here in Bermuda. Recognizing that we cannot reduce our rates without seriously affecting future viability, we can regain our former levels of occupancy by giving more for less and we have to acknowledge that it is our responsibility to provide our guests with what they want rather than what we think they want (Dodswell 1993:250–251).

Dodswell notes that "numerous studies" (sponsored by government, the private sector of the tourism industry and academics acting in an independent capacity), have been carried out in order to identify remedies for the underlying decline in Bermudan tourism. The study reported here may provide an alternative analytical methodology in support of this process.

The Model

The Ricardian analysis is used here to study the Bermuda hotel market. This economic analysis is appropriate for the study of markets where sunk costs have a large impact. Sutton (1991) provides a detailed discussion of sunk costs and their impact on market structure. Other relevant literature includes Gabszewicz, Shaked, Sutton, and Thisse (1981) and Shaked and Sutton (1982). The Ricardian analysis is based on the assumption that (a) the quality of hotels varies and this places restrictions on prices that may be charged; (b) hotel quality can be measured and ranked in terms of revenue-generating capacity; (c) hotel room rentals are completely unstorable and that an empty hotel room represents revenue lost forever; and (d) the Bermuda resort hotels market is dominated by a relatively small number of firms which have market power and a considerable degree of oligopolistic interdependence.

It may be pointed out that many of these assumptions are really just fundamental characteristics of the hotel industry. Thus, the choice of the Ricardian methodology is particularly appropriate in this context. The Ricardian analysis can be illustrated with a simple model, drawn from Baum and Mudambi (1994). A full game theoretic presentation of the results is available in Masson, Mudambi and Reynolds (1994).

Suppose that there are a total of six hotel units, ranked by quality from 1 to 6. Consider the following outcome:

Revenue Generating Capacity	100	90	80	70	60	50
Quality Ranking	1	2	3	4	5	6

It is important to bear in mind that the units are quality-differentiated and cannot be aggregated together. Thus, a simple demand-supply model (with a homogeneous output) is inappropriate in this context.

The point is to concentrate on the strategic aspects of oligopolistic price-setting, and hence restrict attention to the case where price affects market share, but not market size. This is not an unreasonable simplification, particularly in the Bermudan context, where travel prices would tend to outweigh hotel prices in determining the pool of potential customers.

First, consider the "underestimated demand" scenario. Suppose that the demand is for six or more units. Now all the available units can be sold at their maximum revenue-generating potential. The equilibrium price vector is [100,90,80,70,60,50]. This "high-price" equilibrium is insensitive to market structure (i.e., regardless of whether the ownership of units is dispersed or concentrated, these equilibrium prices prevail). Now consider the more common "overestimated demand" scenario. Suppose that the demand is for only four units. Here the equilibrium is sensitive to the pattern of unit ownership.

The competitive case. Suppose that the ownership of the units is completely dispersed (i.e., there are six hotels each with control over one unit). Then, although its revenue-generating capacity is 60, the price of the 5th unit is competed to zero (since only four are demanded). This unit then determines the Ricardian equilibrium price vector to be

[40,30,20,10,0,0], since 100 − 60 = 40, and so on. This is the essence of Ricardian analysis. In Ricardo's classic analysis, when the firms (or rentiers) are competitive, the best unused unit determines the equilibrium prices generated by the superior quality of the units which are used.

The oligopoly case. Concentrated unit ownership, as in the Bermuda resort industry, is now considered. For notational simplicity, let there be two hotels, A and B. Let hotel A own units 1, 3 and 5, while hotel B owns units 2, 4, and 6. If hotel A charges the Ricardian prices 40 and 20 for its two best units (and obtains a total payoff of 60), it can sell these in the face of any non-negative prices chosen by hotel B. Hence any strategy involving lower prices for these units cannot be an equilibrium. Similarly, hotel B can always obtain 30 and 10 for its best two units (with a payoff of 40).

If either hotel charges prices higher than the Ricardian prices and offers all its units for sale, the best response of its rival will be to undercut these prices by a small amount and divert sales to itself. Thus, any price vector higher than the Ricardian price vector cannot be an equilibrium if all units are offered for sale. If hotel A withholds unit 5, it can charge 50 and 30 for its best two units and sell these in the face of any non-negative prices offered by hotel B. Clearly this option is made possible by the ownership of multiple units. This strategy yields a certain payoff of 80.

Hotel B's best response to this is to withhold the last unit and charge 90 and 70 for its best two units. Hotel A counters by charging 100 and 80 for its best two units. Hotel B now responds with price undercutting—charging 90-ϵ, 70-ϵ, and 50-ϵ for its three units, where ϵ is arbitrarily small. As hotel A responds with further price shading, this leads inexorably back toward the Ricardian prices and the cycle begins again.

Hotel B knows that hotel A will not accept a payoff of less than 80. Thus, hotel B can add 2/3(10) = 6.667 to the price of its best two units. This strategy yields a payoff of 36.667 + 16.667 = 52.334. Hotel A has no incentive to undercut these prices, since by doing so, and selling all its units, it gets a payoff marginally smaller than 80—i.e., (46.667-ϵ) + (26.667-ϵ) + (6.667-ϵ) = 80 − 3ϵ. Thus, in the oligopoly case, prices fail to fall to the Ricardian (or competitive) level even in the face of excess supply. Hotel A's payoff is at least 80 and hotel B's payoff is at least 52.334. These compare with the Ricardian payoffs of 60 and 40 respectively.

More importantly, there is no single price configuration that can be sustained as an equilibrium. Any prices chosen by one hotel are subject to opportunistic undercutting (with an appropriate pattern of withholding) by its rival. In the language of game theory, there does not exist an equilibrium in pure strategies. The actual prices chosen cannot be predicted analytically; they are likely to vary widely in a manner unconnected with the actual level of excess supply. Parenthetically, however, it is possible to prove that there always exists an equilibrium in mixed strategies for any number of players (Masson, Mudambi and Reynolds 1987).

The Data

Monthly data are analyzed for the period 1980–1992. The market segment studied is the large resort hotel sector. Peak (Spring and Summer) rates and off-peak (Fall and Winter) rates are compiled from various issues of the *Bermuda Hotel and Guest House Rates* published by the Department of Tourism. The deficiencies inherent in the use of published rate sources are recognized, but these provide the only consistent and comparable data for the purposes of this study. Reliable data on actual, achieved rates are not available in published form. There were a total of 10 resort hotels operating in Bermuda during the period studied. Seven of these reported rates throughout the period of study. The rate used is the double occupancy rate per person with the modified American plan (MAP), the most common rate charged in Bermuda. The rate includes room, breakfast, and dinner. Rates are quoted in terms of the Bermuda $, which is tied 1 : 1 to the US dollar.

In 1992, these 7 hotels controlled 2,527 rooms, capable of accommodating 6,464 guests. This compares with the total of 81 hotels of all types registered under the Hotels (Licensing and Control) Act of 1969, and the total of 4,237 rooms on the island.

Monthly tourist arrivals and the monthly consumer price deflator are taken from the *Bermuda Digest of Statistics 1992* published by the Ministry of Finance. In addition, an alternative deflator is constructed using the wages of hotel staff reported in the *Digest*. The most recent figures are obtained directly from the Department of Tourism. Monthly hotel occupancy figures are obtained from the Bermuda Hotel Association.

Hotel rates must be deflated since they pertain to a period of over a decade. Deflating with the overall Bermuda consumer price index, one obtains what is termed "the 'A' hotel rate series." To guard against the chance that resort hotel prices may move asynchronously with overall inflation, a deflator from the wages of hotel workers (tipped and untipped) is constructed. This deflator increases by more than the overall consumer price index, lending support to the belief that Bermuda hotels have been under input cost pressure through the 80s. Using this latter index generates what this article calls the "B" series. Both the "A" and "B" series are analyzed here.

Estimation and Results

Methodology. The fundamental prediction of the model is that hotel rates should behave asymmetrically relative to demand forecasts. If demand is underestimated (excess demand), then the rates should remain relatively high. However, if demand is overestimated (excess supply), the absence of a genuine market equilibrium should ensure that rates do not behave systematically.

Testing the model involves two steps. First, one generates demand forecasts and combines these with the actual level of demand to determine whether a period is characterized by excess demand or excess supply. If forecasted demand in a period is less than the actual level of demand for that period, there is excess demand. Similarly, if forecasted demand for a period is greater than actual demand, the period is characterized by excess supply. (Since the rates used are published rates that are put out in advance, there is reason to believe that they would be based on forecasts.)

Second, after the periods have been categorized into excess demand and excess supply periods, the rates in these periods are examined. Periods with excess demand should show rates which vary systematically (i.e., the greater the excess demand, the higher should be the rates). Periods with excess supply should not exhibit this characteristic (i.e., higher excess supply *need not* be associated with lower rates).

Four measures of excess demand (and supply) can be used. The first two measures are generated by forecasting occupancy. One forecasts occupancy first, using total arrivals and then using air arrivals only. The latter forecast is expected to be the finer one, as total arrivals include cruise arrivals, which are not generally hotel customers; statistically this proves to be the case.

The second two measures are generated by forecasting total arrivals and air arrivals. It may be argued that arrivals give hotels an idea of the potential clientele. These measures are expected to be cruder than the measures based on occupancy with the results to provide supporting, rather than primary evidence. Of these two measures, total arrivals is the cruder one (for the reason mentioned above).

Demand forecasting. In the demand forecasting stage, arrivals, and occupancy are estimated. No quantitative or qualitative forecasts of hotel demand for Bermuda are available. Hence one is obliged to construct forecasts from available data. The attempt is to be as parsimonious and as simple as possible in the specification of the forecasting equations, and then subject the specification to diagnostic testing. The tests appear to support the specification adopted.

The following equations, which form a recursive system, are estimated, using monthly data. The appropriate estimation technique is OLS:

$$\text{ARR} = \alpha_0 + \alpha_1{*}\text{YEAR} + \alpha_2{*}\text{DUM} + u_{1t} \quad (1a)$$

$$\text{AARR} = \beta_0 + \beta_1{*}\text{YEAR} + \beta_2{*}\text{DUM} + u_{2t} \quad (1b)$$

$$\text{OCC} = \nu_0 + \nu_1{*}\text{ARR} + w_{1t} \quad (2a)$$

$$\text{OCC} = \delta_0 + \delta_1{*}\text{AARR} + w_{2t} \quad (2b)$$

Here ARR denotes total tourist arrivals, AARR denotes air arrivals, OCC denotes the monthly average hotel occupancy, YEAR is a linear trend term, and DUM is a bi-variate peak period dummy. In equations (2a) and (2b), both YEAR and DUM affect OCC through arrivals—i.e., recursively through equations (1a) and (1b).

Not surprisingly, tourist arrivals in Bermuda show a strong seasonal pattern, with the peak season roughly covering the second two quarters of the year. Estimating equations (1a) and (1b) brings out the strong seasonal pattern, as well as demonstrating that the trend term (YEAR) has limited impact. This is true for all arrivals (1a), as well as for air arrivals (1b). One may conclude that in general, the hotels are competing against each other in a zero-sum game and no time deflator is necessary.

The fit of equations (1a) and (1b) are fairly good. The values of R^2 (adjusted for degrees of freedom) are in excess of 60% and the F-statistic is extremely significant. The Durbin-Watson statistic indicates that autocorrelation is not a problem. The hypothesis of a linear functional form is accepted using Ramsey's RESET test.

In order to assess forecasting ability, one tests for parameter stability (the Chow test) and predictive failure (the generalized form of Chow's 2nd test, as presented in Pesaran, Smith and Yeo 1985), with 6, 12, and 24 forecast periods. In all cases, the null hypotheses of stable parameters and predictive accuracy cannot be rejected.

Estimating (2a) and (2b) it is found, equally unsurprisingly, that arrivals have a strong significant effect on occupancy. The fits of equations (2a) and (2b) are extremely good. The values of adjusted R^2 are over 90% and the F-statistic is extremely significant. Again, the Durbin-Watson and Ramsey RESET tests are easily passed; the forecast diagnostics indicate excellent forecasting ability. (Further details of all estimation results, including plots and numerical tables of actual and forecasted values for all orders of forecasts are available from the authors.)

The predicted values from equation (2a) are denoted by FOROCC1. Now consider

$$\text{ERROCC1} = \text{OCC} - \text{FOROCC1}$$

This is the difference between the actual and forecasted resort hotel occupancy rate. This represents the demand-supply status of the resort hotel market. If this value is positive, the actual occupancy rate is higher than forecasted and there is excess demand. Conversely, if it is negative, the actual rate is lower than forecasted and there is excess supply. The variable FOROCC2 is generated using equation (2b), and

$$\text{ERROCC2} = \text{OCC} - \text{FOROCC2}$$

The secondary proxy for the demand-supply situation is generated from equations (1a) and (1b). The predicted values from (equation 1a) are denoted by FORARR1 and the difference ERRARR1 = ARR − FORARR1, is constructed. As above, if this value is positive, the actual tourist arrivals are higher than forecasted and there is excess demand; if it is negative, actual arrivals are lower than forecasted and there is excess supply. Similarly, the variable FORARR2 is generated using (1b) and ERRARR2 = ARR − FORARR2.

Forecast analysis. The resulting values of ERROCC1 and ERROCC2 are divided into five classes, creating proxy variables that are denoted by OCEXALL and OCEXAIR, respectively. Similar construction using ERRARR1 and ERRARR2 creates a second pair of proxies that are denoted by AREXALL and AREXAIR, respectively. Table 3

Table 3. The Quantitative Definitions

ERROCC1 and ERROCC2 (%)	OCEXALL and OCEXAIR
> +20	1
+5.0 to +19.9	2
+4.9 to −4.9	3
−4.9 to −19.9	4
< −20	5
ERRARR1 and ERRARR2 ('000s)	AREXALL and AREXAIR
> +10	1
+2.5 to +9.9	2
+2.49 to −2.49	3
−2.50 to −9.9	4
< −10	5

shows the quantitative definitions of OCEXALL and OCEXAIR and AREXALL and AREXAIR.

Periods when the proxies take the value of 1 or 2 are characterized by excess demand, while those when they take the value 4 or 5 are characterized by excess supply. Periods when they take the value 3 represent times of rough market clearing. The Ricardian model predicts that such periods should witness price behavior that dovetails with the systematic price pattern of excess demand periods. Note that the construction of all the excess demand proxies takes into account the seasonal effect, as the seasonal dummy enters into the creation of the estimates FORAARi and (through recursion) FOROCCi, (i = 1,2). Hence, further introduction of the seasonal component into the Ricardian analysis is unnecessary; indeed, it would be methodologically incorrect.

Tables 4–7 present an analysis of hotel rates. Only overall results for

Table 4. Occupancy Proxy for Excess Demand Based on All Arrivals[a]

Part One:	OCEXALL	Mean Rate (A)[b]	# Obs.
	1	141.10	28
	2	134.76	35
	3	110.17	35
	4	132.39	35
	5	146.45	42
Pooled Mean		132.79	175
Pooled *SD*		43.56	

Part Two: Analysis of Variance: (A)[b]

Source	Degrees of Freedom	Sum of Squares	Mean Square	*F*-Statistic	*p*-Value
OCEXALL	4	34375	8594		
Error	170	322524	1897	4.53	0.002
Total	174	356899			

[a]Hotel rates used are the modified American plan, per person, double occupancy.
[b]Rates deflated by the Bermuda Consumer Price Index.

Table 5. Occupancy Proxy for Excess Demand Based on Air Arrivals[a]

Part One:	OCEXAIR	Mean Rate (A)[b]	# Obs.
	1	149.64	42
	2	105.79	28
	3	71.57	14
	4	142.00	42
	5	117.02	49
Pooled Mean		132.79	175
Pooled *SD*		41.22	

Part Two: Analysis of Variance: (A)[b]:

Source	Degrees of Freedom	Sum of Squares	Mean Square	*F*-Statistic	*p*-Value
OCEXAIR	4	68103	17026		
Error	170	288796	1699	10.02	0.000
Total	174	356899			

[a]Hotel rates used are the modified American plan, per person, double occupancy.
[b]Rates deflated by the Bermuda Consumer Price Index.

"A" rates are presented, since the results for "B" rates are not qualitatively different (more details with regard to hotel rate analysis are available from the authors). Analyzing the hotel rate data along the dimension of OCEXALL (Table 3), using analysis of variance (ANOVA), it is found that for excess demand and equilibrium periods (1,2, and 3), rates behave systematically. The "A" rates decline from 141.10 in periods of high excess demand (OCEXALL = 1) to 110.17

Table 6. Arrivals Proxy for Excess Demand Based on Air Arrivals[a]

Part One:	AREXAIR	Mean Rate (A)[b]	# Obs.
	1	155.05	42
	2	142.50	35
	3	98.04	14
	4	102.86	35
	5	138.10	49
Pooled Mean		132.79	175
Pooled *SD*		40.81	

Part Two: Analysis of Variance: (A)[b]:

Source	Degrees of Freedom	Sum of Squares	Mean Square	*F*-Statistic	*p*-Value
AREXAIR	4	73759	18440		
Error	170	283140	1666	11.07	0.000
Total	174	356899			

[a]Hotel rates used are the modified American plan, per person, double occupancy.
[b]Rates deflated by the Bermuda Consumer Price Index.

Table 7. Arrivals Proxy for Excess Demand Based on All Arrivals[a]

Part One:	AREXALL	Mean Rate (A)[b]	# Obs.
	1	156.44	35
	2	127.45	28
	3	120.18	42
	4	119.45	28
	5	138.17	42
Pooled Mean		132.79	175
Pooled *SD*		43.63	

Part Two: Analysis of Variance: (A)[b]:

Source	Degrees of Freedom	Sum of Squares	Mean Square	*F*-Statistic	*p*-Value
AREXALL	4	33260	8315		
Error	170	323638	1904	4.37	0.002
Total	174	356899			

[a]Hotel rates used are the modified American plan, per person, double occupancy.
[b]Rates deflated by the Bermuda Consumer Price Index.

in equilibrium periods (OCEXALL = 3). A Least Significant Difference (LSD) test for paired means indicates that these means are significantly different.

However, during periods of excess supply, rates behave quite erratically. The average rate for periods of low to medium excess supply (OCEXALL = 4) is 132.39. It *increases* to 146.25 for periods of high excess supply (OCEXALL = 5). Again, the LSD test indicates that these means differ significantly from those in excess demand periods, and from each other. The pattern is mirrored by the "B" rates, but not as strongly. However, the LSD test still indicates that the "B" rates for different excess demand levels are significantly different, from each other and from the excess supply periods.

The OCEXALL proxy is constructed using all tourist arrivals and is thus contaminated by the large cruise arrivals component, which should not affect hotel rates. The OCEXAIR proxy is constructed using only air arrivals, and is a cleaner representation of the excess demand scenario. Indeed, as expected, the predictions of the Ricardian model are supported much more strongly by analysis using OCEXAIR. Both "A" and "B" rates decline smoothly as excess demand declines, but behave erratically during the excess supply periods. The analysis of variance suggests much more significant rate differences for both "A" and "B" rates. The *F*-statistic rises from 4.53 to 10.02 for "A" rates and from 3.11 to 4.04 for "B" rates. These results are presented in Table 5. Similar results using the cruder AREXALL and AREXAIR proxies are presented in Tables 6 and 7. The results mirror those discussed earlier, and can be considered further evidence supporting the main thesis.

Three final issues can be considered. The Ricardian model specifies that the quality of the good supplied be non-uniform. Analyzing rates along the dimension of hotel identity, it is found that there is significant rate variation. The F-statistic for the "A" rates is 3.01 with (6,173) degrees of freedom compared with a critical value of 2.15 at the 5% level and 2.91 at the 1% level. Further, qualitative observations support this conclusion. There is considerable variation in the facilities available at the major resort hotels. For example, the Hamilton Princess, one of the largest properties in the sample, has virtually no sporting or major leisure facilities, while its sister hotel, the Southampton Princess, offers golf, tennis, and swimming among other facilities. This is evidence supporting the claim that the "quality" among the resort hotels is not uniform.

Secondly, the question of heterogeneous market perceptions by the different hotels is addressed. If the hotels arrived at differing forecasts, it could lead to asymmetric rate variation of the type discovered here. If this were true, then calculated excess demands should vary systematically across the hotels (i.e., each forecasting equation should give rise to an identifiably different pattern of forecasting errors).

In order to test this hypothesis, one randomly selects from the excess-demand-proxy/hotel-identity matrix to obtain balanced blocks. Then two-way ANOVA to examine the interaction term is carried out. In all cases the interaction term is insignificant. One is led to reject the hypothesis that the hotels react to excess demand proxies differently. This supports the contention that the hotels' market perceptions are uniform and that the results obtained do, in fact, support the predictions of the Ricardian model.

Lastly, one should consider whether excess demand periods occur mostly in the "peak" season and excess supply periods occur mostly in the "off-peak" season. If this were the case, it would suggest that perhaps it is the nature of the season rather than the nature of the forecast error that is driving the results. It is found, however, that the correlation between the four excess demand proxies and a peak-off-peak dummy varies between a low of -5.3% and a high of 5.5%. Ordinal measures using Spearman's rank correlation coefficient yield similar results. Forecast errors seem to be unrelated to the nature of the season.

CONCLUSIONS

This paper's conclusions must necessarily be somewhat tentative, but they can be drawn to reflect both the practical and theoretical. The Ricardian model has a contribution to make within the context of hotel occupancy forecasting. The predictions of the model are shown to be valid in the context of Bermuda's resort hotels. Thus, drastic price cutting and potentially suicidal price wars have not been a feature of this sector of the Bermuda hotel industry over the period under analysis. While the oligopolistic nature in the large resort hotel sector is not the only contributing factor to this situation, its significance should not be underestimated.

Bermuda, in many respects, represents the ideal destination for the application and testing of the Ricardian model because of it's size, location, wealth and comprehensiveness of data sources and the nature of the tourism markets with which it deals. However, the model does have application and implications in the context of other island tourism destinations. It is the authors' intention to undertake further studies in this area. In general, the approach that is piloted here can be used as a vehicle to support supply and pricing policies within resort hotels elsewhere, complementing the more short-term benefits of yield management techniques already utilized within the industry. □□

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