Supply & Demand in the Lodging Industry:

A Simultaneous Equation Model of the Center City

Philadelphia Hotel Industry

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Introduction

Tourism is a huge industry in the United States. It employs eighteen million people and directly generates $174 billion in payroll income. Travel and tourism also provide local, state and federal governments with $98.7 in tax revenue. In Philadelphia, tourism is the second largest industry. Hotels are the infrastructure of the tourism industry and, therefore, play a significant role in the nation's economy.

It is important to note that by tourism and travel, I am not simply referring to leisure travel. Though leisure travel is a critical factor in studying the lodging industry, business and convention travel can by no means be ignored. In fact, leisure travelers account for nineteen percent of Philadelphia's hotel room nights. The remaining eighty-one percent is accounted for by convention attendees and business travelers, with forty-six percent and thirty-five percent respectively.

The study of the lodging industry is vital to its survival. If resources are not properly or efficiently managed, profitability is diminished or lost. Supply and demand is the fundamental concept behind any industry in the economy. Supply of new hotels cannot be easily or rapidly adjusted on any large-scale basis because the addition of a hotel takes a large investment and a long time. The process of building a hotel takes an average of four years from the preplanning stage through its opening date.

The purpose of this paper is to study the lodging industry. I will examine the mechanisms that drive the industry's operations. Supply will be discussed, but the main

focus is on demand, since that is what ultimately propels the industry. Both factors are relevant, however, because they determine profitability, which is the universal goal of capitalism. Throughout a general analysis, I will use Philadelphia as a case study. Finally, I will develop an economic model that will specifically apply to the Center City Philadelphia Hotel Industry.

Studying the lodging industry can help determine if an area is benefiting from investments related to the industry. For example, the Philadelphia hotel demand can be analyzed to determine revenue is being generated from investment in the Pennsylvania Convention Center. This will be considered when making future investment decisions, such as a possible expansion of the Convention Center.

The city has also invested a great deal of funds on marketing Philadelphia as an overnight destination with the "Philly Overnight" campaign. This is an attempt to recover some of the revenue lost due to the events of September 11th and the sharp decline in travel and slowdown of the economy as a whole that ensued. Hotel room demand is the main determinant in measuring the success of this marketing campaign.

Finally, hotel demand can be utilized by other organizations and governments as a tool in urban development and policy-making decisions. Philadelphia overestimated convention demand so they are attempting to fill the extra hotel rooms by attracting tourists to such new sites as the Constitution Center. Also, the Greater Philadelphia Hotel Association, a non-profit member organization, is interested in hotel demand for many reasons, including assessing how much lobbying for lower tax rates on hotel stays would benefit the local lodging industry.

In contrast to this time lag in supply, demand fluctuates daily. The concept of demand forecasting is critical to achieving the equilibrium of supply and demand. Demand forecasting, however, is not as simple as it may seem to be. The precise factors that drive overall demand are both difficult to determine and to capture in a forecasting model. There are also factors that are unique to different regions, types of hotels, etc. Also, as I previously mentioned, there are three types of travelers- leisure, business and convention- that comprise room demand.

Demand forecasting is not only relevant when considering new supply, but for other reasons as well. Hotels can charge different rates to different guests. The leisure traveler, for example, will generally have to pay more than a convention or business traveler does, especially if they have booked at a group rate. If demand by leisure travelers is expected to be high, it may be more profitable for a hotel to turn away a group, which would stay at a discounted rate, and have more rooms available for those who will pay a higher rate. The industry, because most costs in the production process are fixed, practices price discrimination to maximize profits. Specific price discrimination decisions are crucial to a hotel's success, and this explains the importance of short-term demand forecasting, as well as the necessity to break down the demand of each type of traveler.

The forces of supply and demand drive entry and exit into and out of the industry. Demand forecasting is crucial in making investment decisions to build new hotels. Also, it can help hotels that are struggling determine if recovery is possible and, if so, strategies to accomplish it. Accuracy in forecasting has proven to be somewhat of a problem, as

many areas at different points in history have experienced supply booms that future demand cannot sustain.

Philadelphia is currently facing an oversupply situation, as the building of the Pennsylvania Convention Center and economic prosperity caused a rapid expansion of the city's lodging industry in the late 1990's. 5, 841 rooms were added to the city between July 1995 and March 2003. This represents an eighty-nine percent increase to the 6,559 rooms that existed prior to this expansion period. A huge portion of this supply boom occurred in preparation for the 2000 Republican National Convention, which has not been followed by any convention or event that draws anywhere close to the number of people that the RNC did to the city.

Background

I have outlined the reasons that supply and demand studies and forecasting are crucial to the lodging industry. As one can imagine, a significant amount of research has already been conducted on this topic. The overall consensus seems to be that lodging demand is a dynamic concept that is difficult, if not impossible, to fully capture in an economic forecasting model.

The most obvious factor is the overall state of the United States economy. Tourists cut back on leisure travel, fewer groups can afford conventions, and businesses begin cutting overnight travel out of their budgets during an economic slowdown. Different studies have used different measures of the economic picture, however, when forecasting lodging demand.

Wheaton and Rossoff (1998) focused on the overall lodging industry when they studied the relationship to Gross Domestic Product (GDP). They examined both the demand and supply sides of the industry to determine if they moved with the economic cycles of the United States. Data during the period 1969 through 1994 showed that hotel room demand moved with Gross Domestic Product (GDP). According to this study, lodging demand grew 1.3 percent for every one percent rise in GDP. The supply side of the industry did not display the same correlation with GDP. Using the levels of new investment as the measure of supply, Wheaton and Rosoff found no relationship with the cycles of the U.S. economy. Because rental rates for hotel properties are adjusted gradually in the long-run, instead of being adjusted for short-term economic fluctuations, the business cycle fails to affect hotel investment. The gradual adjustment explains why new investment, or supply, displays long-run movement. Vogel (2001) reports that Gross National Product (GNP) is the measure most related to hotel room demand. For every one percent increase in GNP, there is a 0.75 percent increase in lodging demand. This is a statistic that can only be applied to the lodging industry as a whole, since GNP is a measure of the economy as a whole. Other studies have found relationships between hotel room demand and employment growth, disposable personal income and exchange rates, respectively.

Culligan (1990) looks at both supply and demand in the lodging industry, much like Wheaton and Rossoff. He points out that in the 1965 through 1990 period, growth in demand has occurred in remarkably close relationship to growth in supply. He suggests the "Field of Dreams" theory, which is, "If you build it, they will come". In some cases, such as with new niche hotels, supply may stimulate demand growth. He begins with the

simple assumption that the market tends toward equilibrium. He does not provide any statistical analysis to support his claims, but he cites historical examples of demand growth following supply booms. This has occurred in areas and at times even when demand is not expected to meet the new supply.

In addition to macroeconomic factors, socio-demographic factors may affect hotel markets. Palakurthi and Parks (2000) found that age-distribution, income-distribution, occupation and gender are statistically significant variables in determining hotel room demand. The results also showed that education level and the number of children in a household were not significant factors. They then paired off the four significant factors and ran regressions on the six pairs individually. Some of their results include: people aged 25-54 years have a significantly higher demand than all other groups combined, people with incomes above $35,000 per year have the highest demand, those employed as managers/professionals have the highest demand, and males have higher demand than females in the 25-54 year group. Though these results may seem to be obvious, the study statistically confirmed these common sense assumptions.

Douglas and Barden (2000) analyzed daily occupancy performance to examine demand for different days of the week. Some hotels, especially those located in tourist markets, experienced higher demand on the weekends. Hotels in business areas, or those with meeting facilities, had higher demand during the week. This concept, once again, may seem like common sense but now also has statistical confirmation. It is a concept that is vital to a hotel's profitability, as determining daily occupancy trends for individual hotels can greatly assist in resource management and pricing decisions.

Other studies have been more specific in terms of the factors that they study. Canina and Walsh (2003) look at the effects of gasoline prices on hotel room demand. The study was conducted after a Choice Hotels promotion, in which they distributed five-dollar gas cards to guests who booked stays in advance. Obviously, the marketing team believed there to be a relationship between gas prices and room demand. Also, an earlier paper reported that fourteen percent of travelers would travel less or cancel trips because of rising gas prices induced the interest of the researchers. Data on gas prices and branded-hotel rooms sold between January 1998 and December 2000 were used to study the relationship. The results indicated that a one percent rise in gasoline prices caused lodging demand to drop 1.74%. This was a larger impact than was expected by many experts in the field.

Finally, government policy may affect the hotel industry. Hiemstra and Ismail (1992) analyze the impact of occupancy taxes on hotel room demand. Most occupancy taxes are ad valorem taxes, which means that a one percent increase in taxes translates into a one percent increase in room rates. The impact of occupancy taxes on lodging demand was statistically significant, with an overall elasticity relationship of –0.44%. This means that for a one percent increase in occupancy tax, hotel room demand will decrease by 0.44%. Considering that the average national occupancy tax is 12.4% and the average tax rate in Philadelphia is 14% (American Economics Group, Inc. 2003), occupancy taxes can have a relatively drastic impact on demand. Researchers point out that a change in occupancy rate of three percent can be the difference between profit and loss for a hotel.

Because group forecasting can be vital to the profitability of hotels, setting aside an excess number of rooms for groups represents lost revenues, when these rooms could have potentially been sold to higher-paying leisure travelers. This study found that the factors affecting group forecasting error are: the time before arrival that the group reservations are made, the type of hotel, the size of the hotel, the dependence on group business of the hotel, the occupancy rates at the hotel, the frequency of forecast updates, and the timing of forecast updates. The identification of the factors that affect group forecasting error may help to improve the overall process and contribute to the profitability of hotels.

Model and Data

Data from this study was gathered from the "2002 Lodging Survey Report" produced by the Horwath Horizon Hospitality Advisors, LLC. It estimated the occupancy trends for the Center-City Philadelphia lodging market. The report provided data on hotel room supply, market occupancy rate (percentage of available rooms that were occupied), airport passenger traffic, and market price data (the average daily rate (ADR) of a hotel room). I adjusted this ADR data so that it was in real terms by using the GDP deflator.

The other variables included in my model are economic indicators, which are relevant to my model because the hospitality industry is sensitive to the health of the economy. I used real disposable personal income per capita (in 2000 dollars), real interest rate, and real GDP growth rate directly in my model. I also needed GDP deflator data to translate market ADR data into real terms. I obtained this various economic data

on several government websites, which were the Bureau of Economic Analysis, the U.S. Department of Labor Bureau of Labor Statistics, and the Federal Reserve.

I ran my regressions using the two-stage least squares method to avoid the simultaneity problem that my model would otherwise have had. Simultaneity is a problem where an explanatory variable is jointly determined with the dependent variable. This would mean that there are endogenous variables, or variables determined within the system, on both sides of the model equation. When the simultaneity problem is present, the estimator is biased, inefficient, and inconsistent. The two-stage least squares method remedies the simultaneity problem by using the exogenous variables and rearranging the variables to eliminate biasedness.

In my model, the endogenous variables are price and occupancy rate. The exogenous variables, or instruments, are total air passenger traffic, real interest rate, real disposable income per capita, real GDP growth rate and total quantity of rooms supplied. It is a two-equation system, with one equation for each of the endogenous variables. I used the two stage least squares method to eliminate the simultaneity problem in my two-equation system. Because of autocorrelation, all independent variables were lagged. In the occupancy rate model, lagging the variables improved the Durbin-Watson statistic from 1.215 to 1.341. In the price model, it increased from 0.76 to 1.3046.

Results

Table 1 displays the means and standard deviations of each variable in my model. Some of the independent variables were significant in predicting the dependent variable, while others were not. The variables of both the demand and the supply models are listed

in Table 2, with their individual estimates and t-values also given. The significant variables are denoted according to their level of significance.

The overall occupancy rate model is statistically significant, which is shown by the F-statistic. The R-squared value is relatively high, also indicating a good model. The model accounts for 76.32 percent of the variability in the occupancy rate.

The independent variables included in the occupancy rate equation were market price, real disposable income per capita, real GDP growth rate, total air passenger traffic, and total quantity of rooms supplied. Market price, total air passenger traffic, and total quantity of rooms supplied were each significant in determining occupancy rate. Real disposable income per capita and real GDP growth rate were not significant variables in this model. It is interesting to note that the variables representing economic indicators were the insignificant ones. The estimates indicate that an increase of one million passengers in total air passenger traffic would cause a 0.9159 percentage point increase in occupancy rate. If this model holds true, the upcoming opening of the new International Terminal at the Philadelphia International Airport that is scheduled for May 2003 should have a relatively large impact on occupancy rate of Center City hotels (holding the supply of rooms constant).

The impact of adding rooms is smaller, with an addition of one thousand rooms leading to a 0.005 percentage point decrease in occupancy rate. This number is probably so small because rooms are generally added when hotel developers believe that there is demand for them. If their estimations are correct, adding rooms should counteract the increased demand, and there should be no noteworthy impact on overall occupancy rate.

The price variable in the occupancy rate model is significant, but the result is contrary to expectation. For a one dollar increase in price, occupancy rate would increase by 0.22 percentage points according to this model. A decrease in occupancy rate would generally be expected when prices rise. Perhaps this is not the case because of the time gap between demand fluctuations and price changes.

The ADR equation is also statistically significant. The R-squared value in this model is high, with 95.84 percent of the variation in the average daily rate explained by the independent variables. The independent variables representing real interest rate and real GDP growth rate are not statistically significant in this model. Occupancy rate and real disposable personal income per capita are significant in predicting market price. Once again, economic indicators are the insignificant variables. This model differs from the occupancy rate model, however, in that real disposable income is significant in predicting price. It seems that with a one hundred dollar increase in disposable personal income per capita, there is a 0.57 dollar increase in the market ADR. A one percentage point increase in occupancy rate indicates a 0.77 dollar increase in market ADR. This follows from an increase in demand causing prices to rise, which follows standard supply and demand logic.

The models for occupancy rate and market ADR are significant overall models and include several significant independent variables. The results are logical, with the exception of a price increase corresponding to an increase in demand. The price variable is significant in predicting occupancy rate, however, and there may be a reason that this is the case in the practical world. For example, I suggested a time lag in the reaction of demand to price.

The most surprising result that I have come across is the insignificance of real GDP growth rate and real interest rate. In the majority of the reading that I did in preparation of constructing my own model economic indicators were recognized as a factor in predicting occupancy rate and price in the lodging industry. Perhaps I did not select the best indicators to determine the state of the economy as it relates to the hotel industry. Perhaps people assume that these factors have an impact because it would seem to be common sense, but it is not actually the case. Further research would have to be done on my part to determine an explanation for this result.

Conclusion

The purpose of this study is to examine the mechanisms that drive supply and demand in the Philadelphia lodging industry. Supply and demand are obviously the driving forces behind the lodging industry, as it is in the economy as a whole. This is evident in the significance of price in the occupancy rate model and vice versa.
I found that economic indicators did not have the impact that they are thought to have on hotel occupancy rates and prices. With the exception of disposable personal income have a statistically significant impact on market ADR, economic indicators were insignificant in predicting demand and supply in my model. This is the most interesting result that I found, especially because it was contrary to other studies that I researched. Air passenger traffic has a significant impact on the prediction of demand, with a one million passenger increase resulting in a 0.92 percent increase in occupancy rate. Also significant in predicting demand is total quantity supply of rooms and, as I mentioned above, market ADR. In the supply model, occupancy rate and real disposable personal income were the

significant variables. The models are significant in predicting demand and supply of hotel rooms in Center City Philadelphia, which was the main purpose of the conduction of this study.

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Table 1: Means and Standard Deviations

Variable	Mean	Standard Deviation	Minimum	Maximum
Occupancy Rate	65.21	5.04	57	73
Market ADR	109.42	19.42	76.69	141
Disposable Income	21160.04	2798.72	16931	26355
GDP Growth Rate	2.98	1.91	-1.9	7.2
Air Passenger Traffic	16681	5703	9008	24918
Quantity Supplied	2331	622.5	1726	3902
Real Interest Rate	4.05	2.45	-2.23	8.11

Occupancy Rate = average percentage of total rooms filled in Center City Philadelphia in year t.
Market ADR = real market average daily rate in Center City Philadelphia in year t.
Disposable Income = real disposable personal income per capita in 2000 dollars in the United States in year t.
GDP Growth Rate = real GDP growth rate in the United States in year t.
Air Passenger Traffic = total air passenger traffic (in thousands) at the Philadelphia International Airport in year t.
Quantity Supplied = total quantity of hotel rooms supplied (in thousands) in Center City Philadelphia in year t.
Real Interest Rate = real interest rate in the United States in year t.

Table 2: Demand and Supply Models

Demand Model: Occupancy Rate

Variables	Estimates	t-values
Intercept	71.7524***	5.58
Market ADR	0.2264*	1.78
Disposable Income	-0.001566	-1.34
GDP Growth Rate	-0.1088	-0.33
Air Passenger Traffic	0.0009159*	1.9
Total Quantity Supplied	-0.0005593***	-2.7

N = 24
DW = 1.34
R-squared = 0.76

Supply Model: Market ADR

Variables	Estimates	t-values
Intercept	-65.6854***	-3.37
Occupancy Rate	0.7676***	2.98
Disposable Income	0.005758***	8.56
GDP Growth Rate	0.3595	0.75
Real Interest Rate	0.4217	0.73

N = 24
DW = 1.30
R-squared = 0.96

Occupancy Rate = average percentage of total rooms filled in Center City Philadelphia in year t.
Market ADR = real market average daily rate in Center City Philadelphia in year t.
Disposable Income = real disposable personal income per capita in 2000 dollars in the United States in year t.
GDP Growth Rate = real GDP growth rate in the United States in year t.
Air Passenger Traffic = total air passenger traffic (in thousands) at the Philadelphia International Airport in year t.
Quantity Supplied = total quantity of hotel rooms supplied (in thousands) in Center City Philadelphia in year t.
Real Interest Rate = real interest rate in the United States in year t.

* significant at the 0.1 level
** significant at the 0.05 level
*** significant at the 0.01 level