

Comparable Challenges: A new approach to performance measurement

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Received (in revised form): 6th April, 2005

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ABSTRACT

KEYWORDS: performance measurement, revenue management, benchmarking, Comparable Challenges, pricing

Estimating the impact of pricing and revenue management decisions is critically needed for making a wide variety of decisions. A variety of methods and performance metrics have been proposed; many are currently used. Each has its particular virtues and drawbacks. The method described here, termed Comparable Challenges, provides quantitative estimates of how well revenue management and pricing decisions perform, while normalising for the market conditions that exist when these decisions are made. The authors believe that the present proposed approach goes further than other metrics, and that it also has widespread applicability, including non-revenue management applications. Comparable Challenges can provide insights on specific actions to take to increase the effectiveness of a revenue management programme. This is where the full value of Comparable Challenges lies — in the ability to use knowl-

edge about performance to influence and improve revenue management decision making.

INTRODUCTION

Consider the following scenarios.

- A publicly held company has recently invested several million dollars to improve its pricing and revenue management decision capabilities. The new system and other changes have now been implemented for several months. The company wants to estimate the incremental financial benefits it is receiving from its investment and communicate the information to the management team and its shareholders. How can it estimate the benefits?
- Reductions in staff at an airline have resulted in an expanded workload for its revenue management analysts. What is the financial impact of the increased workload?
- After five years in her position, one of the Revenue Managers at a major hotel chain is leaving her position. As the firm prepares to hire a new Revenue Manager, are they better off paying more to hire an experienced Revenue Manager, or should they hire someone with less experience for a lower salary?
- In an effort to increase its rental revenues, a self-storage facility has elected to become more aggressive in periodically raising the monthly rates on longer-term renters. Is the new policy increasing its revenues and profits, or would the facility have been better off carrying out its previous policy?
- A car rental company wants to award a performance bonus to its best-performing Revenue Manager. How should the company evaluate their performances?

Whether it is for estimating the performance of an individual, evaluating the financial impacts of a new pricing policy,

staff turnover or a host of other reasons, estimating the impact of pricing and revenue management decisions is critically needed information for making a wide variety of decisions. A variety of methods and performance metrics have been proposed; many are currently used. Each has its particular virtues and drawbacks.

The method described here, termed Comparable Challenges, provides quantitative estimates of how well revenue management and pricing decisions perform, while normalising for the market conditions that exist when these decisions are made. As such, the authors believe that the present proposed approach goes further than other metrics, and that it also has widespread applicability. Using a Comparable Challenges approach will enable companies to estimate better the financial impacts of their revenue management programmes and other initiatives aimed at improving profitability, and thereby position them to evaluate better a broad range of alternative policies and investment options facing them.

To the best of the authors' knowledge, the performance metric approach proposed here to estimate the impact of a revenue management programme is new. It is a comprehensive metric that addresses the problems typically encountered by other comprehensive performance metrics.

PERFORMANCE MEASUREMENT APPROACHES

Before describing the present proposed approach to estimate the incremental revenue attributable to revenue management, it is useful to consider the alternative ways in which this can be done. In general, estimates of incremental revenue can be obtained in four basic ways:

- (1) the difference between treatment and control groups in a randomised experiment

- (2) a comparison of pre- and post-revenue management performance under comparable conditions (eg revenue management operating statistics, benchmarking)
- (3) a percentage of the theoretical maximum that could be obtained (eg Performance Opportunity Models)
- (4) the output of a simulation which compares what the pre-RM policy would have done with what actually occurred.

The four approaches are not mutually exclusive. They can be used in combination. Each approach relies on different types of information, involves varying levels of effort, and may offer different insights.

These are technical approaches to performance measurement. While many companies do use these approaches, it is far more common for companies to rely on what might be called administrative approaches to performance measurement. Perhaps the two most common administrative approaches are:

- (1) year on year comparisons (or month on month, etc.), often against an expectation of a fixed percentage gain
- (2) comparisons against budget, where budget is set by some decision maker or decision makers, and performance is evaluated against it.

The administrative approaches have the advantages of simplicity and, by the choices made about the percentages and budgets, often serve as a managerial device to set goals and standards. They are also often taken seriously, however, as measures of performance, sometimes even serving as the basis for performance bonuses. In this, they are typically unfair and misleading, since they generally do not account for changing conditions during the period they

are applied, and tend to be set too broadly, covering a variety of activities with differing potentials. Thus, they risk rewarding poor work done in favourable conditions and penalising superior work done in poor ones, and of course, they can be manipulated to do so. In the authors' experience, managers are generally aware of these issues, but the methods are accepted because they are so deeply embedded, and no clear alternative is in sight. The Comparable Challenge method does offer that alternative.

The four technical alternatives are listed roughly in the order of their distance from direct empirical measurement. In a sense, this also approximates the desirability of using each approach. Being closer to direct empirical measurement reduces opportunities for 'estimation methodologies' to bias or prejudice the performance estimate. These measures will be discussed in terms of revenue management, but it should be clear that outside specific operating statistics, the discussion has implications for other initiatives aimed at enhancing the bottom line.

The first approach, a randomised experiment, is the most direct and technically reliable if its implementation does not produce biasing interactions but, typically, it is the most intrusive in a business environment. It restricts implementing revenue management to roughly half the potential sites for a sufficient period to ensure that the experiment covers the range of seasonal behaviour. This not only reduces the potential benefits by half for that period, it forces an implementation process that may be contrary to sound business practice.

Recognising that businesses cannot typically focus on running their operations with the primary purpose of measuring their revenue management capabilities, true random selection of sites is rarely possible. Instead, it might make business sense to choose the sites with objectives such as

demonstrating revenue management's value or identifying and correcting implementation problems. Both of these business-oriented objectives might suggest choosing sites whose Pricing staff have the strongest capabilities. Doing so, however, would invalidate the approach of using treatment and control groups to estimate the direct impact of revenue management. And even where sites can be selected through a truly randomised process, it is difficult to conceive of situations where this can be carried out on an ongoing basis.

For such reasons, randomised experiments are rarely chosen outside strict research environments, even though the approach can provide the most definitive estimate. (No other method can so convincingly handle unmeasured and even unidentified variations across sites and time.)

The second method, pre- and post-comparison, is the basic method utilised. Its virtue is that, like randomised experiments, it compares real revenues under actual operating conditions. Its validity depends on whether the pre-revenue and post-revenue management conditions are comparable; that is, whether they reflect the same revenue management challenges, so that a comparison between the previous procedures and the revenue management system reflects the system's capabilities. The failure to ensure the validity of the comparison, of course, is the weakness of conventional year on year performance measures.

Currently, this approach is practised in some industries in the form of revenue management operating statistics or benchmarking (vs competitors or vs previous time periods). The operating statistics are of limited use, however, in that they generally focus on a single decision type, and revenue management operating statistics may only be available for some decision types. Comparable Challenges facilitates measuring the impact of the entire range of revenue management decisions. For example, airlines

measure *spoilage* as a way of estimating the extent to which Revenue Management prematurely rejects reservations. Spoilage, which is the number (or percentage) of seats that are empty on a flight which sells out, is a revenue management operating statistic, because the decision on when to close a flight is under the control of Revenue Management. Spoilage, therefore, reflects how well Revenue Management sets a flight's overbooking authorisation and can be used for pre- and post-comparisons. Spoilage, however, is the result of only one of many decisions that are controlled by Revenue Management.

Rather than use multiple performance metrics, some companies have used a single comprehensive performance metric as a benchmark to estimate the impact of their revenue management programme. For example, in the hotel industry, revenue per available room (REVPAR) has often been used as the benchmark measure. Some airlines have used a similar measure, revenue per available seat mile (RASM).

While such measures have been useful, they are also prone to serious measurement error, as they do not account for changes in competition, nor do they isolate the impact of general economic conditions. Consequently, while a hotel's REVPAR may decline owing to a decrease in overall demand for hotel rooms, the revenue management programme might still be improving the hotel's financial performance. This would not be reflected in the REVPAR performance measure, however. Competitive benchmarking, so that relative changes in these measures are considered rather than absolute changes, can address some of these limitations, but such benchmarks can also be misleading; for example, group and volume accounts, investments in revenue management decision support, staff turnover and other factors may all unknowingly be skewing these comparisons.

There is a strong intuitive appeal to using a single comprehensive performance metric, rather than combining multiple measures. It answers, after all, the basic question businesses must address: ‘How much money are we making because of our actions?’ And, if a single measure is reliable, it can be easier to communicate the impact of revenue management, internally as well as externally.

The third method, gauging performance against a theoretical maximum, depends on having a sound estimate of unconstrained demand. In the authors’ experience, it is always difficult to estimate the accuracy of such estimates. Performance measures that are based on such estimates can be useful, but they tend not to be sufficiently credible to support external communications; most companies are also cautious about using such estimates for more than a guide on how well they are performing.

The fourth method, simulation, requires modelling pre-revenue management policies. This can be an expensive process, and one which hides numerous judgement calls in a mathematical black box. In the authors’ view, this method is most easily justified when more direct methods cannot be applied. For example, when the comparative method proposed leaves comparison ‘gaps’ that need to be filled, simulation may be useful in such situations to help fill in these gaps. Sometimes, however, it will make sense to simply admit there are gaps and leave them be, instead of making expensive and questionable estimates — this is a judgement call.

COMPARABLE CHALLENGES

The method of Comparable Challenges has something of an Economics 101 flavour. It matches situations when inventory availability (supply) and market responses to pricing (demand) are comparable, and asks the question, how well was this challenge handled? Since revenue management tries

to maximise revenue for a given state of inventory and market conditions, the comparison allows a measure of how well revenue management accomplishes its task. The authors believe that this comparison can frequently be made using simple criteria and available information.

Depending on data availability and industry, the method allows comparisons to be made at multiple stages in the sales cycle. This can be particularly useful if revenue management responsibilities are ‘handed off’ to different staff during the selling window.

To identify when a firm faces comparable pricing challenges, one needs to find periods that are equivalent in terms of ‘selling opportunities’ (eg potential demand) and inventory availability. Doing so establishes a basis for making fair and reasonable performance comparisons. It is worth noting that comparing revenue performance across equivalent opportunities allows for more meaningful analyses than are typically possible with month on month or year on year comparisons. Although revenue management performance is frequently measured in such terms, there is also widespread recognition that such measures may be biased because supply and market (eg demand) conditions are not equivalent during the compared periods. That companies continue to rely on such measures, even while knowing that the comparison may not be fair, may simply be an issue of ‘going with the best we’ve got’. By creating a Comparable Challenges measure, this may no longer be necessary.

This section contains two illustrations of how the Comparable Challenges approach might be used. In the first example, the approach is applied to estimate the impact of revenue management decisions at a self-storage facility. In the second, its application to a multi-family housing complex is considered. In both these examples, pri-

cing, as opposed to capacity control, plays a dominant role in revenue management.

These industries were chosen, in part, to highlight that Comparable Challenges was designed to be consistent with the stronger focus that revenue management systems are now having on pricing policies. This is also the area where current revenue management metrics are least developed.

Self-storage

Background

A self-storage facility provides temporary storage space on a monthly basis. The facility provides a range of unit types and sizes. Units may be priced differently based on physical attributes (eg second story units are less expensive than ground floor units; climate controlled units are more expensive than those that are not). While the minimum rental period is a month, many customers rent storage space for long periods of time. Some units are rented by businesses, others by individuals for personal reasons. After six months, the facility is free to increase (or decrease) a customer's monthly rental fee at any time, as long as the customer is given at least 20 days' notice of the proposed fee change.

The self-storage facility has recently implemented a revenue management system. The system provides price recommendations for new leases as well as when and by how much rates should be raised for existing customers. The facility's management wants to know how much incremental revenue is being generated by the

system, relative to its pre-revenue management system policies and procedures.

Comparable Challenges opportunity

In this example, the primary objective of the performance metric is to estimate the *incremental* (if any) revenue earned by a self-storage facility as a result of revenue management policies (eg when should prices be raised on existing customers) and price recommendations. Only revenue which accrues as a result of the current pricing policies should be considered. For example, assume revenue management was implemented in March, and the incremental revenue earned by the self-storage facility in June is to be estimated. The rental revenues received in June resulting from transactions occurring since the implementation of revenue management arise from three sources:

- (1) new leasing starts in June
- (2) leases that began after revenue management was implemented and are still active in June
- (3) active leases to which a rate increase was applied since the date of the revenue management implementation.

Month by month, one might have the situation depicted in Table 1.

Table 1 assumes revenue management was implemented on 1st March. There were 22 new starts in March. Seventeen of these leases continued into April. No leases received a rate increase in March. In April, there were 18 new starts and 73 rate

Table 1: Post-revenue management lease activity

<i>Number of leases</i>	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>
New starts	22	18	20	21
Post RM continuing leases	NA	17	31	50
Post RM rate increases	NA	73	64	59

increases. A total of 31 of the March and April starts carried over to May. Twenty new starts occurred in May. There were 64 leases active in May that received a rate increase after the implementation of revenue management.

The June income attributable to the pricing policy in place since March is:

(revenue from the 21 June Starts)
 + (base revenue from 50 active leases begun prior to June, but post-revenue management implementation)
 + ('rate increase' revenue from the 59 leases that received a rate increase after the implementation of revenue management)

To estimate the impact of the revenue management programme, one must now estimate how much of this revenue is attributable to the current revenue management (ie since March) pricing policy. That is, how much of this revenue would the self-storage facility have earned in the absence of the revenue management programme? The difference between the two is the incremental revenue attributable to revenue management. This paper now considers how to specify conditions where equivalent challenges were faced, so that revenue comparisons can be made.

As noted above, to estimate when the self-storage facility faces comparable revenue management challenges, it is necessary to find measures that enable periods where the facility faces equivalent market conditions and inventory availability to be identified. Doing so establishes a basis for making reasonable performance comparisons.

There are a variety of metrics that could be used for this purpose. This example uses *occupancy rate on the last day of the previous month* to define what the facility has to offer to the market. For market conditions, a net occupancy change measure is defined

as the *average move in–move out percentage of the previous three months*, to define the market's response to the facility's recent pricing policy. Other measures are also possible but, for purposes of illustrating the Comparable Challenges methodology, these measures work well.

It is worth noting that occupancy is not used as a measure of demand but, rather, provides an indication of the extent to which unit availability is constrained and the need for the self-storage facility to manipulate demand. It can be divided into three bands:

- (1) high, to account for resource constraints
- (2) medium, to reflect business as usual conditions prevail
- (3) low, to recognise that extraordinary efforts are likely to be in effect to generate business.

The net occupancy change measure reflects how the economy is responding to the facility's recent price/product position (except at high occupancy when availability is constrained). This measure is also divided into three bands:

- high, indicating increasing occupancy
- medium, indicating stable occupancy
- low, indicating decreasing occupancy

Together, these statistics roughly define the situation revenue management must make the most of. They were chosen to reflect the categorical differences which drive business decisions.

For each month and unit type, a classification matrix can be constructed using three levels of occupancy and three levels of net occupancy change, defining nine possible scenarios (shown in Table 2).

Returning to the example used for Table 1, there is now a basis for comparison to answer the question raised earlier for the

Table 2: Classification MATRIX

		<i>Net occupancy change percentage</i>		
		<i>Increasing</i>	<i>Stable</i>	<i>Decreasing</i>
<i>Occupancy</i>	<i>High</i>	HI	HS	HD
	<i>Medium</i>	MI	MS	MD
	<i>Low</i>	LI	LS	LD

month of June: How much of the income earned by the revenue management programme is attributable to revenue management? Using the Classification Matrix, one can compare instances of pre-revenue management and post-revenue management revenues for the same cell for June. (In practice, the comparison would probably be against a month during a ‘selling season’ — periods where demand tends to be fairly constant. As seasons can be several months long in many industries, this allows for an increase in the number of comparisons available in the data.)

Post-revenue management, if June falls in the MI cell, look for pre-revenue management instances of June in the MI cell and average their monthly revenues (revenues for each instance would be computed using the approach described in conjunction with Table 1). Then subtract the pre-revenue management June average from the post-revenue management June’s revenue. *The result is an estimate of the incremental revenue obtained by the revenue management system at the same point in the season, with the same inventory, facing the same historical response to the facility’s position in the market.*

The measure accounts for the revenue from new starts, including promotional income, rate increases and length of rental (since it tracks the income from starts and rate increases across time).

For a company owning multiple self-storage locations, comparisons can be made at various levels of aggregation, including

store, geographic region and various combinations of unit types, as analytic purposes require and to the degree reasonable sample sizes permit.

Accounting for the effects of promotions not attributable to revenue management, large changes in the competitive environment (such as opening or closing of competing facilities), other disturbances and long-term trends in organisational capability can be handled on a case-by-case basis by regression discontinuity estimates of the magnitude of effects. Regression discontinuity (with regression diagnostics) has the advantage over simple before and after comparisons by distinguishing between changes due to ongoing trends from specific event-based effects. It does, however, require additional analyses, and for this reason should only be applied to situations where substantial revenue implications are at stake.

Measures that determine a revenue management system’s contribution compared with no revenue management system are not measures of its continued contribution — except to the degree that the pre-revenue management period, or some extrapolation from it, remains a fair comparison. Over time, the self-storage facility would have an option of introducing new baseline revenue measures (or simply resetting the baseline revenue measure) so that incremental revenue estimates will measure the quality of system operations. Revenue increases and decreases made within post-revenue management

periods would reflect changes in the current state of the system and its utilisation.

In short, the net occupancy change classification measures how the economy is responding to the policies and rates set by the self-storage facility. Occupancy rate (or the converse, vacancy rate) measures the level of inventory available to respond to the economy. Taken together, these factors provide the underpinnings of this measurement approach, as they describe the basic supply and demand situation the self-storage facility faces when making its pricing and marketing decisions. Consequently, they are used to classify comparable situations when making before-revenue management and after-revenue management comparisons. The quality of revenue management decisions and policies is reflected in the change in revenue across these comparable situations. Adjustments can be made to ensure that extraordinary circumstances and other trends are included in the measurement. The measure can be used initially to determine the level of benefits, and subsequently to ensure the level is maintained or increased. The example illustrates how simple measures of these situations are sufficient to make a credible performance measure.

APARTMENT RENTAL: MULTI-FAMILY COMPLEXES

Background

A three-story multi-family apartment complex offers a variety of one, two and three bedroom apartments for rent. Rental rates vary based on an apartment's location and attributes (eg fireplace, ceiling height, view, etc.). Each day, apartment complex managers are given a *rate sheet* that is generated by the complex's revenue management system, containing a list of the vacant and soon-to-be-vacant apartments that can be rented and the monthly rental rates for each. When an apartment is

rented, renters sign a lease for six, nine or 12 months. The tenant's rent cannot be increased during the term of the lease.

Although the revenue management system provides pricing guidance, on-site management staff have some leeway in their ability to negotiate rates for new leases. As turnover of on-site management tends to run fairly high, the complex's Revenue Manager wants to monitor the rental performance of new staff. The Revenue Manager wants to identify any opportunities that are being missed as well as provide useful and informative guidance to on-site staff.

Comparable challenges opportunity

In this example, the Comparable Challenges approach has a slightly different focus from that in the previous example. Rather than estimating total revenue impact, the Revenue Manager is looking to provide guidance on what types of decisions might be improved and how to do so.

Once again, one wants to define situations where the apartment complex is faced with comparable pricing challenges. One possibility is to define selling opportunities as high, medium or low, depending on recent traffic intensity during the past four weeks. Apartment complexes have different ways of measuring this, including a count of the number of prospective tenants who have visited the complex. Similarly, inventory availability could be classified as high, medium or low, depending on vacant apartments and the number of still occupied apartments for which the tenant has given notice that they will soon be moving out (a 30-day move out notice may be required). For example, low availability could be defined as when vacancies plus soon-to-be-vacant apartments are less than 3 per cent, medium availability could be defined when this ranges from 3 to per cent, and

Table 3: Classification matrix

		<i>Traffic intensity</i>		
		<i>High</i>	<i>Medium</i>	<i>Low</i>
<i>Vacancies</i>	<i>High</i>	HH	HM	HL
	<i>Medium</i>	MH	MM	ML
	<i>Low</i>	LH	LM	LL

high availability could be defined as when these apartments comprise more than 8 per cent of inventory. To ensure like with like revenue comparisons, the classifications may need to be made by groupings of apartment size.

As shown in Table 3, these categorisations allow construction of a 3 × 3 Classification Matrix.

Once suitable classifications have been established, a range of performance metrics can be computed to assess the revenue management performance of the apartment complex. For example, the following metrics might be used as a basis for better understanding and comparing financial performance when re-renting apartments:

- after units become vacant, the average rental revenue per day for periods of 30, 90, 180 and 365 days from unit vacancy dates (so, prior to a unit being re-rented, rental revenue would be \$0 for each day of continued vacancy)
- the probability of re-renting a unit within 7, 30 or 60 days after it becomes vacant
- the average number of days a unit stays vacant between rentals
- when a unit is re-rented, the difference between the new rent and the previous rent
- the probability of re-renting a unit within 7, 30 or 60 days at the rental level initially requested upon the unit becoming available for rent

Taken together, these metrics begin to form a comprehensive picture of the success of a complex’s revenue management performance when re-renting apartments and can help identify both challenges and opportunities to be addressed. And, of course, the more general measure of revenue impact would be available.

SUMMARY

The proposed approach could provide many companies with reasonable, ongoing financial estimates of its revenue management performance and, ultimately, the incremental revenues resulting from its revenue management programme, and this approach could be used more generally whenever initiatives are expected to affect the bottom line. The largest practical problem in the approach may be the requirement for modelling where there is no before and after cell match. If the methodology is useful, however, carrying out a data analysis effort could help determine the extent to which this issue is likely to surface and alternative ways that it could be addressed.

For example, where month and cell comparisons are not available, or the data are unacceptably sparse, one of two methods could be employed. Both should be understood as ways of filling in when more direct measurement is not possible. The simplest is using the average benefit for the asset type and time period in a comparable region. Whether or not such an approach is appropriate cannot be determined until some data analysis is carried out. For example, in the self-storage example, there is a risk that the average will be based on a biased sample, one containing a disproportionate number of stores at which revenue management has had the least impact.

If the above method does not prove satisfactory, a more sophisticated regression-based simulation approach might be

required. Again, using self-storage as an example, the model could be derived from a set of variables designed to allow comparisons when occupancy and occupancy change cell matches are not available or reliable. Potential explanatory variables include last previous cell match, lagged occupancy and seasonal per cent occupancy change, number of units of a type, revenue per available storage unit, number of storage units, change in revenue per available storage unit, days into season, revenue change from the closest unit types and months, or for the facility as a whole (when no unit type comparison is credible) — all aimed at finding a predictable relationship between the pre- and post-difference in revenue and post-revenue management conditions. The best set of variables would be determined during the process of building the model.

The models could take the standard regression form. Y , the predicted variable, would represent the percentage revenue difference pre-implementation and post-implementation of revenue management (and later as an ongoing post-revenue management comparison). The various X variables (the predictors) would represent the type of variables listed in the paragraph above. The B s represent the weights assigned to each of the X variables, producing the optimal (minimal squared error) linear prediction.

$$Y = (B_1 \times X_1) + (B_2 \times X_2) + \dots + (B_n \times X_n)$$

The model predicts the outcome of Comparable Challenges. Consequently, the benefit estimate can be understood in exactly the same way as the measure, although the estimation is the result of a less direct methodology.

To the extent that the performance measures proposed are affected by non-revenue management policies during a measurement period, such as changes in the competitive environment, changes in organisational capability and larger economic trends, their impacts could be handled by tracking them independently (probably by using regression discontinuity measures) and making appropriate adjustments.

As the examples illustrate, the method must be customised to fit both an industry's measures of supply and demand, and the questions it tries to answer. *It cannot be applied without sufficient substantive understandings of the business.* The method's broader relevance highlights an often undervalued aspect of revenue management, which is to focus business decisions on reliable, empirically grounded, quantifiable performance measures. It offers an alternative to piecemeal performance measures where overall impact cannot be reliably gauged, mathematical abstractions of questionable relevance, and budgets and year on year comparisons that are inherently unfair, because performance is measured against varying conditions. Comparable Challenges provides direct answers to basic business questions; answers that are grounded in data and account for the conditions under which decisions are made.

The insights made possible by Comparable Challenges can then be used to identify specific actions to be taken to increase the effectiveness of the firm's revenue management programme. In essence, this is where the full value of Comparable Challenges lies — the ability to use knowledge about performance to influence and improve revenue management decision making.